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Focus on integrated FEED

Earl Tipton, Technip, USA, and Sanjeev Mullick and Andy McBrien, AspenTech, USA, explain how E&C firms can utilise the latest plant design tools and integrated workflows to deliver high value customer projects.

THE last few years have seen significant investment in new production capacity worldwide in oil and gas, refining and petrochemicals. This has been driven by an increase in global economic growth and the investment opportunities created by higher energy prices. As a result, engineering and construction (E&C) firms are experiencing a high demand for their services for new plants, revamps and expansion projects.

In addition, projects are being implemented in a highly dynamic economic environment today. For owner/operators, time to market is critical, and so is agile and energy efficient designs customised to their requirements, with capital efficiency. To achieve these multiple objectives E&Cs and their customers must:

- Consider alternatives during project concept stage.
- Optimise designs and size equipment with consistent data.
- Perform accurate cost estimation and ROI analysis.
- Ensure safety, reliability and operability of the designs.
- Embrace global execution and concurrent engineering.
- Efficiently manage design data throughout the project lifecycle.

The challenge for E&Cs

These imperatives and the competing demand for staff are placing additional pressure on E&C companies to streamline their process engineering workflows and to ensure that their project teams have access to tools which can help them deliver optimum designs while working in the most efficient and productive ways.

Much of the focus is on front end engineering and design (FEED) work processes, with the objective of finding better ways to integrate the key activities and to support collaboration between the internal and external groups that are working together on a project. Such initiatives have led to the development of industry best practices for integrated FEED processes, which are enabled by the latest process engineering software solutions.

An integrated FEED process

The core FEED workflow steps are:

- Conceptual design: initial simulation and analysis of the proposed design alternatives, including economic trade offs.
- Cost estimating: economic evaluation of the proposed design(s) including identifying the capital investment and operating costs.
- Equipment design and rating: outlining the basic configuration and sizing of key process equipment such as heat exchangers.
- Operability studies: analysing the safety and controllability of the chosen process and equipment layout.
- Detailed process engineering: developing the detailed process design package and plant design, including further cost analysis of the chosen project scenario.

Although each of these steps is well established in its own right, the challenge facing the leading E&C firms is to understand how to integrate them so that tasks may be carried out concurrently by teams in different disciplines, and often working in different locations and time zones.

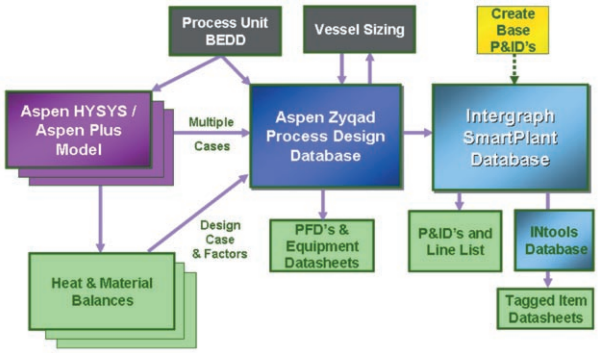

Figure 1. Technip's project workflow, tools and deliverables.

For this it is important they use data and information that is accurate and consistent, and made easily available to them.

If this can be achieved successfully, there are significant potential benefits, not just in the quality and economic performance of the final plant design, but also in the productivity of the engineering and design teams involved in the project. It is estimated that up to a 30% improvement in engineering efficiency can be achieved by utilising an integrated FEED process.

A number of E&C firms have adopted a FEED approach based on such integrated technologies, and are seeing the benefits throughout the project lifecycle. One such company is Technip, which, for its process engineering needs, has standardised on AspenTech's aspenONE Process Engineering application suite and its options.

Business drivers for implementing an integrated FEED approach

The key business drivers moving E&C firms to implement integrated FEED systems are:

- Best practices.
- Quality.
- Retaining talent.

This sets some fundamental requirements for the enabling software technologies to support the integrated FEED process. These business drivers and the technology requirements are discussed in more detail below.

Best practices

Many companies have adopted 3D modelling as an engineering best practice, but to maximise value from these systems they need to be tied to the process design world. So the first requirement is that the simulation tools used throughout the project lifecycle for process simulation and optimisation must be capable of working together with other applications for cost estimation and equipment design and rating. This allows process configurations under consideration to be efficiently analysed and refined.

Quality

Owner/operators do not pay extra for quality. They expect quality to be inherent in the work they are paying for. Therefore, E&Cs have to adopt best practices and information technology to deliver more quality at less cost. Once a process configuration has been decided upon, a collaborative FEED platform is needed to integrate data from multiple sources, such as the process simulation, equipment design and cost estimation applications. It then allows multiple users to work concurrently on developing the process flow diagrams, equipment lists and equipment datasheets that form the core of a process design package.

A platform, such as Aspen Zyqad, plays a vital role in supporting collaboration between the different engineering disciplines and ensuring that consistent data forms the basis of the project. Benefits for E&Cs are obvious: better business margins and a good reputation (which brings in more business). Owner/operators get the benefit of better design quality, which means less rework during the construction phase. For example, piping rework can be reduced to less than 0.5% by use of a collaborative design platform with links to intelligent P&ID and 3D systems.

Retaining talent

A third business driver for many global E&Cs is to retain their best and most productive talent. This is important for client satisfaction and to maintain the E&C's competitive edge. Engineering staff must therefore be given the latest tools and opportunities to advance their skills. Technip, for example, invests a significant amount on education and training as an incentive to retain people.

Objectives of an integrated FEED workflow

Given that firms such as Technip are driven to implement an integrated FEED process by several strategic reasons, what are some of the tactical objectives to be achieved?

Minimise manual data entry errors

For starters, integration ensures that all consumers are using the latest project data, resulting in consistency between the deliverables and less rework. Manual data entry, with its inherent possibility of errors, is reduced. As an example, the integration of Aspen HYSYS and Aspen Tasc+ automates the transfer of stream properties from a simulation to heat exchanger design software. Furthermore, through Aspen Zyqad, heat exchanger specification sheets can be automatically completed.

Analyse design alternatives for rapid process development

Another important objective is to accurately compare design options. During conceptual design several alternatives may be explored. They must be analysed for process performance, energy efficiency, capital costs and operating costs. With Aspen HYSYS integrated with Aspen Icarus Process Evaluator (IPE), Technip's process engineers can compare the economics of fully developed conceptual designs. This enables rapid process development.

Improve cost estimating process

Good estimating requires close alignment of process and the estimating groups. Thus, there is a need to have tools to foster collaboration. The process engineer is the best person to develop the process design and its equipment list, but not the best person for the infrastructure/civil works. Aspen IPE serves as an effective bridge to help the process engineers within Technip meet the estimating world halfway. Aspen IPE speaks the estimator's language, and the estimator can then pick up and develop the detailed estimate in Aspen Kbase, including the rest of the infrastructure requirements.

Provide standard design templates for licensed technologies

Technip and other E&Cs are also finding value with integrated tools to reuse designs, especially with licensed technologies. With a standardised process design, the investment in creating a design template in Aspen Zyqad and its suite of integrated tools leads to faster execution of subsequent projects.

Engineering work process: technologies and best practices

Conceptual design to process design

Once a conceptual design has been chosen and the basic design completed, the next phase is the production of an integrated FEED/process data package. This step often starts with intelligent process flow diagrams (PFDs). PFDs are a critical step if data is to flow through a series of design tools. As each piece of equipment is added to the drawing, either as individual items, reused packages, or even an entire PFD from a previous project, a datasheet is created and intelligently linked to the drawing. If imported from a design template, all the data from the previous project appears automatically.

Process design to detailed design

Smart connectivity allows imported simulation data to display automatically on the equipment datasheets. Simulation data is easily managed in Aspen Zyqad, which integrates each engineer's design updates with the work being done by other engineers in other disciplines and locations. In addition, Aspen Zyqad also serves as a permanent storage of the design basis for each piece of equipment (especially valuable when the design is handed from one engineering firm to another, then to the owner. The basis stays with the equipment specification).

Design improvements with dynamics modelling

Another fast emerging best practice is dynamic modelling for new plants. Plant designs that optimise steady state operations are often highly heat integrated, have recycles, and maintain minimum hold ups. This results in complex interactions with respect to control and operations. For these modern designs it is imperative that dynamic behaviour be analysed with rigorous dynamic simulation models, such as Aspen HYSYS Dynamics and Aspen Dynamics. Technip has found that incorporating dynamic simulation early in the project reduces costly rework at a later stage. Besides helping process and control system engineers understand process dynamics and unit interactions, other benefits come from:

- Rigorous design of critical equipment during detailed design (e.g., anti surge control systems for refrigeration compressors).
- Sizing of relief values, depressuring studies, optimising equipment size for sufficient design margins to handle disturbances.
- Identifying startup problems during design phase.
- Improving design for safety, reliability and controllability, and therefore reducing downtime.
- Insights into startup procedures and evaluation of alternatives.
- DCS system checkout prior to commissioning.

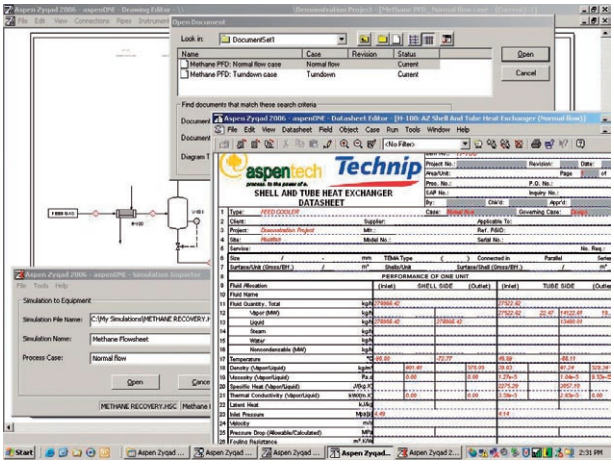

Figure 2. Selected Aspen Zyqad connectivity and deliverables.

Detailed design and intelligent P&IDs.

A truly integrated FEED approach extends beyond intelligent PFDs and into piping and instrument diagrams (P&IDs). Forward thinking E&Cs have used intelligent P&ID tools for years, but their integration with conceptual design is a recent phenomenon. The benefits of these linkages with PFDs have been most apparent for Technip during the development of instrument data and the line lists. This information, combined with dynamic models, can help identify several problems. For example, it may expose deficiencies such as:

- Lack of control for the designed PID loops.
- Lack of instrumentation to solve control problems.

Project examples with integrated FEED

Example 1: Refinery gas oil hydrotreater project

A major US refiner launched a new gas oil hydrotreater project. Initial scope called for a capacity of 42 000 bpd. The conceptual design was to be evaluated for four feed slates, each with a start of run and an end of run case (a total of eight heat and material balances). The simulation and design work took 13 weeks to develop, including links in Aspen Zyqad to simulation and datasheets for over 50 pieces of equipment.

Towards the end of conceptual engineering (a four to five month activity), the client changed the order to 50 000 bpd, and the decision was made to rescope. The E&C firm was able to update the entire design within four working days. This included updating design data, equipment data sheets, cost estimates, and presenting the client with the changes, including the delta cost of the revised project.

Project scope changes happen often and it is better to reuse the design and not start from the beginning. With an integrated FEED infrastructure, E&Cs and their clients are not locked into the initial requirements, and the project can be quickly redesigned to a more optimum set of requirements.

Example 2: Polymer licensor template: process design package

In 2006 Technip delivered on a project for a major chemical company's technology licensing division. The scope was to create a process design template in Aspen Zyqad for the licensor packages. This work proved to be a tremendous success, and clearly demonstrated that projects executed with an integrated and collaborative infrastructure speed up

time to delivery. For example, for these licensed technologies the conceptual phase of the project has gone from one year, with the old manual approach, to less than six months now with Aspen Zyqad. In addition, the deliverable from this new approach represents a better and more optimal design, with more details around equipment design and instrument index, which leads to a more productive engineering effort in the latter phases of the FEED process and beyond.

According to the Process Manager for the chemical company, the implementation of Aspen Zyqad provided significant benefits because it allowed them to create templates from previous projects, and to extend their use to rapidly and accurately execute future projects with reusable design. This enabled faster time to market for their licensed customers.

Conclusion

Until process design and data were accessible it was not known what was possible, but with integrated FEED applications it is now possible to query and datamine them to look for new opportunities, and to think deeply about the process.

The possibilities are endless. It calls for a different type of process engineer; not someone to do hydraulic calculations or fill out data sheets. The goal of next generation process engineering is not to fill out data sheets faster, but to automate the routine tasks and allow engineers to think creatively about new possibilities and options. Technip's experience has shown that aspenONE Process Engineering is a step in this direction, not just for improving FEED, but also to make intelligent P&IDs even more valuable.