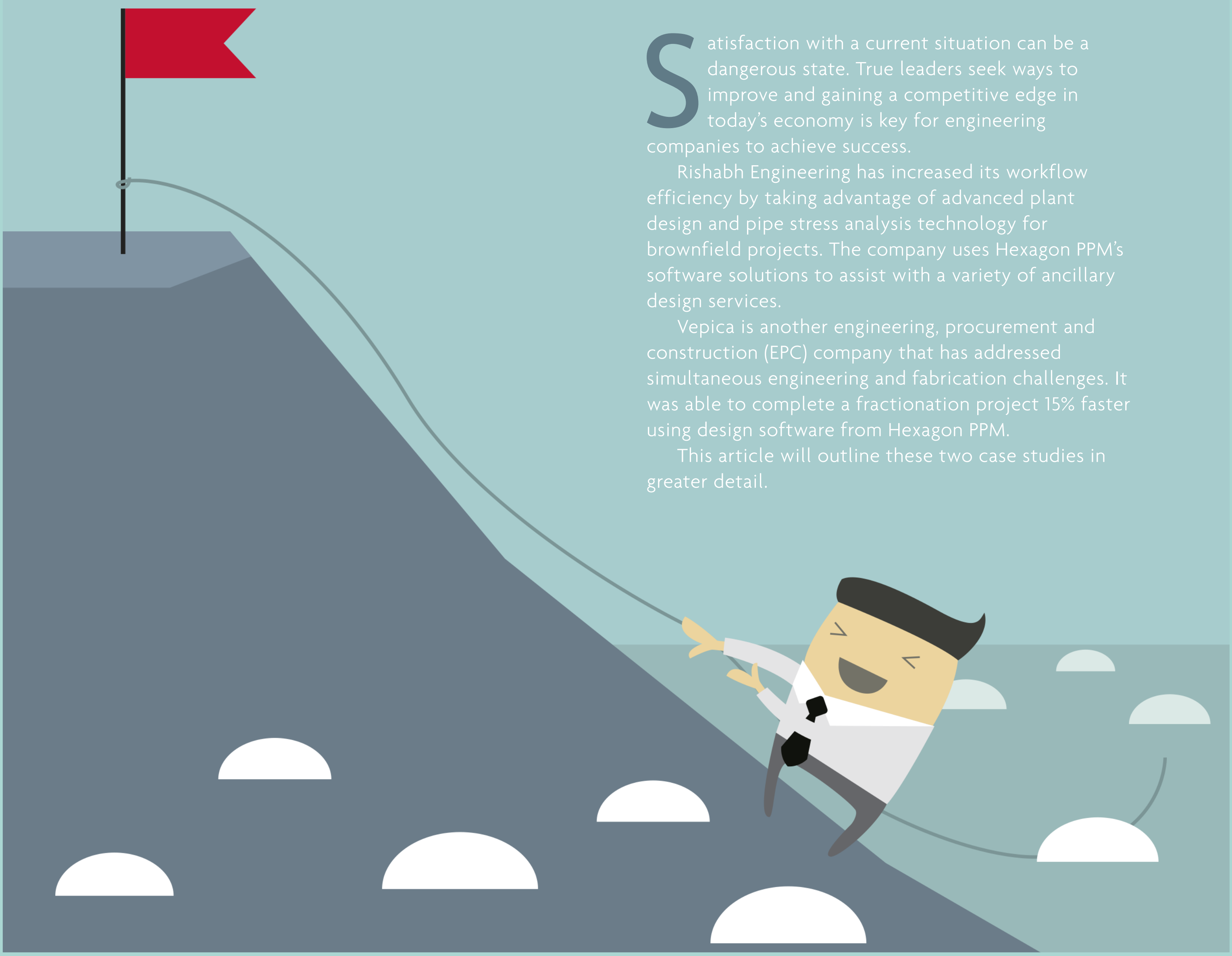
TAKE IT UP A NOTCH

Michael Smith and Jana Miller, Hexagon PPM, USA,
discuss how ancillary design software can assist EPC contractors in both brownfield and greenfield projects.



Satisfaction with a current situation can be a dangerous state. True leaders seek ways to improve and gaining a competitive edge in today's economy is key for engineering companies to achieve success.

Rishabh Engineering has increased its workflow efficiency by taking advantage of advanced plant design and pipe stress analysis technology for brownfield projects. The company uses Hexagon PPM's software solutions to assist with a variety of ancillary design services.

Vepica is another engineering, procurement and construction (EPC) company that has addressed simultaneous engineering and fabrication challenges. It was able to complete a fractionation project 15% faster using design software from Hexagon PPM.

This article will outline these two case studies in greater detail.

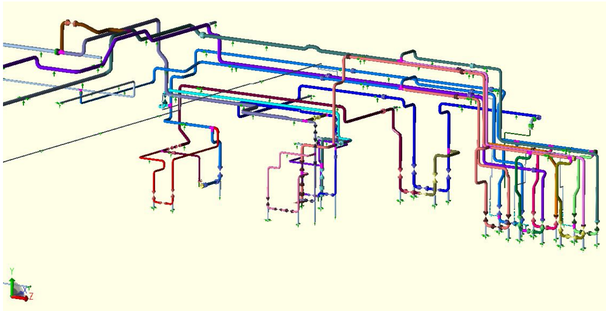


Figure 1. The hot and cold conditions of most of the lines incurred high stresses at branch connections and forces on the pump nozzles.

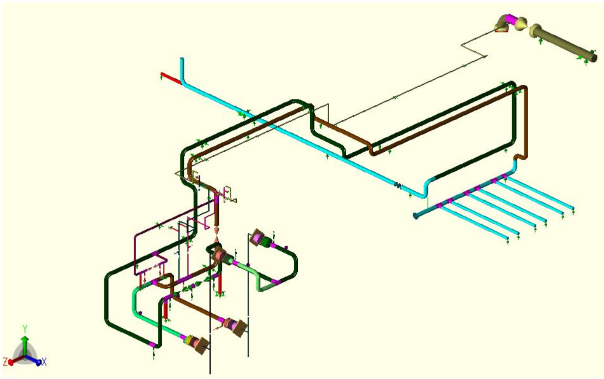


Figure 2. CAESAR II software enabled simple and clear analysis for the entire project.

Refinery piping stress analysis project

Rishabh Engineering was contracted by an EPC client to execute piping stress analysis of 100 systems (approximately 750 lines) of various units at a large refinery in Louisiana, US. The refinery is made up of major refining units including distilling, catalytic cracking, catalytic reformer, alkylation, hydrocracking, hydrotreating, and coking. Products processed or produced daily in the refinery include gasoline, jet-A aviation fuel, low sulfur diesel and anode grade coke. The refinery has a capacity to process 250 000 bpd of crude. The project involved a total of 4000 man-hours and its scope included pipe stress analysis of all stress-critical lines connected to the following systems:

- Catalytic cracking unit.
- Catalytic reformer.
- Alkylation unit.
- Hydrocracker unit.
- Heavy naptha stripper.
- Main fractionator.
- Space constraints and temperature challenges.

Being a brownfield project, a number of technical challenges were faced. Space constraints and existing structures meant that there were less possibilities of changes in pipe routing. Three major revisions were needed in the basic layouts from the contractor. Rishabh Engineering had to overcome frequent and abrupt changes in project specification requirements, along with the unavailability of data.

The hot and cold conditions of most of the lines incurred high stresses at branch connections and forces on the pump nozzles. The system consisted of column piping, with one of the lines connecting two columns to the transfer of fluid from one to another. Due to the difference in temperature between the two columns, high forces and moments were incurred on the nozzles.

Cutting analysis time

To complete the project effectively, Rishabh Engineering used CAESAR II software. Revising the piping layout near the pump nozzles was troublesome, but the problem was addressed by providing spring hangers at required locations and changing the pipe routing wherever possible.

The systems had piping configuration that included multiple feed and return locations, which necessitated defining multiple temperatures to account for hot and cold conditions. The software facilitated simple and clear analysis by enabling nine temperature cases. The team capitalised on the bidirectional compatibility between CADWorx and CAESAR II, using in-house licenses to model the stress-critical systems before importing the files into CAESAR II.

Following R&D, engineers were able to import the .PCF file received from the client with only 18% data loss. This loss was compensated by further modelling in Hexagon PPM's pipe stress analysis software. Thus, the time devoted to modelling the piping systems was reduced by 75% as this originally involved 20% of the total project man-hours.

Isogen software is a built-in module within CAESAR II that supports the automation of piping isometric drawing production. In this project, the software helped the designers extract isometrics and customise them in accordance with the client's templates. This template can be used for both general isometric extraction and issued for construction (IFC) as the information generated is comprehensive and in line with standards required for developing IFC isometrics. The software, therefore, reduces efforts that would otherwise be dedicated to re-modelling the system after the incorporation of stress recommendations. This significantly reduced documentation time, effectively decreasing the overall man-hour rate by 7%.

The CAESAR II input graphics module developed analysis models while indicating areas of concern and providing a clear idea of the piping system's flexibility.

While an alternative sustained stress (Alt-SUS) feature has recently been added to the software, before this introduction, a separate lift-off file would be created by discarding the supports on which lift-off was observed. This would effectively translate the load onto the adjacent supports. The team would then analyse whether such an arrangement could sustain the load and if the stresses were within allowable limits.

Alt-SUS reduced this process by half. Therefore, approximately 3500 supports were required for the 100 systems that the team analysed. Of these, approximately 350 – 400 supports required lift-off considerations.

Ultimately, the client's expectations were met by incorporating Hexagon PPM's software, reducing the modelling, stress analysis and documentation time.

Figure 3. Design information from three offices was synchronised into a central database server to create the 3D model.

Figure 4. The client used CADWorx's 3D model for reviews during the fabrication phase of the project.

Figure 5. The 3D visualisation matches the actual as-built facility.

In turn, this resulted in a reduction of actual man-hours by approximately 22%. Thus, while the project was originally estimated at 4880 man-hours, Rishabh Engineering was able to complete the stress analysis in approximately 4000 man-hours.

Fractionation project

Basic Equipment Inc. selected Vepica to design the fractionation facility of a 25 000 bpd atmospheric distillation unit (ADU) in Houston, Texas, US, for processing Crude A (API 38.2°) or Crude B (API 45.8°) in single crude streams or a combination of these two feedstocks.

The facility includes 87 pieces of equipment and 28 500 ft of pipe ranging from 0.75 in. to 24 in. dia. The structural steel totalled 737 400 lbs.

Vepica's offices in Caracas (Venezuela), Bogota (Colombia) and Houston worked on the project. Effective communication among the design teams was paramount to ensure they used the same design procedures to deliver quality results.

The project also required a modular process skid design, raising concerns that valve hand wheels might interfere with adjacent piping. In addition, the client demanded that the last third of the engineering cycle overlap with the fabrication phase of the project, leaving no room for error.

Costly clashes and interferences were common, as were dimensioning and format errors for piping isometrics. These issues often resulted in additional time for rework. And, without a centralised database, there were often errors in bills of materials, resulting in waste. The project's multisite setting required careful management of the central database.

Enhancing data quality

With CADWorx, Vepica was able to synchronise design information from the three offices into one central database server as team members created the 3D model. The company could then automatically produce piping isometrics and accurate material take-offs.

To avoid interferences, Vepica created a report for the client, showing valve orientation by extracting supplemental Isogen data. The report enabled the team to eliminate errors during fabrication and reduce operation times.

The company used CADWorx to maintain quality control, reduce human error, and achieve faster processing times for reports, drawings, and other client deliverables. The client took advantage of the 3D model for reviews during the fabrication phase of the project. The EPC company completed the project in 15% less time than estimated.

Conclusion

As the above two case studies demonstrate, taking action to improve engineering workflows is vital to professional growth. It is important to maintain a proactive stance, as opposed to a reactive one.