# Dynamics of the real world

**Inprocess case study**

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Miquel Angel Alós, PhD, Inprocess, explains how operations teams in the oil and gas industry can use dynamic simulation to avoid disruptions and minimise the impact of unnecessary costs on real plant operations.

# Dynamics of the real world

The oil and gas industry has witnessed seismic downward shifts in barrel prices and uplifts in market competitiveness. Owner-operators are challenged to squeeze more from their operations and engineering, procurement and construction companies (EPCs) are under more pressure to reduce project risk and achieve better alignment with owner-operators to ensure effective management of their client's capital.

Today, companies need to maximise operating performance and achieve quality products faster. The use of rigorous dynamic simulation helps to reach such objectives. Analysing operating scenarios using dynamic process modelling gives owner-operators confidence that new plants start-up safely, meet budgets and perform to plan. Dynamic simulation is vital to successful plant design and operation.

## Gaining reputation

Inprocess's unique services include steady-state & dynamic process simulation and optimisation projects, knowledge transfer & training courses, Operator Training Systems and software licences.

In the oil & gas and refinery sectors, lost production overshadows installation costs, so it is vital that plant designs are robust to minimise downtime. Dynamic simulation can show transient responses that are not determined during traditional steady-state design methods, providing engineers with a deeper understanding of plant operational behaviour, which can be crucial in safety-related equipment sizing. As a process simulation knowledge provider, Inprocess conducts dynamic simulation studies to confirm a safe an efficient design.

Consequently, the net result to a project is significant time and cost savings. From our experience, the pillars of an effective use of steady-state & dynamic simulation to support best engineering design practice are based upon good communications, efficient knowledge transfer and comprehensive support training. Inprocess tailors training programmes to maximise process simulation knowledge and help gain a better understanding of the plant lifecycle and maximise project return on investment.

## Benefits of dynamic simulation

Unlike steady-state simulation, dynamic models factor time, which helps model complex transient behaviour (i.e. change of temperature, pressure, etc.). This type of simulation reproduces real behaviours of a process plant, providing values that correspond to process variables at a given time. These simulations have an interactive interface that helps the engineer understand what it would be like with a real plant and with solutions becoming more precise, fast and easy-to-use. The main benefit of dynamic simulation is the deeper knowledge it provides of the process as a result of improvements in system control design, plant operations and staff training. It enables the verification of the appropriate size of equipment used to determine design constraints covering the plant's normal operation. As the plant goes through many modifications during its lifetime, dynamic simulation provides a means of continuous assessment of the operability of the proposed design solution.

Better design decisions through detailed analysis enable engineers to make the necessary trade-offs and optimise the design. Inprocess employs dynamic simulation to make it possible to simulate a realistic understanding and behaviour of the plant and help improve decision support and safety. In summary, Inprocess adopts dynamic simulation to ensure:

- Reduced project risk with increased costing accuracy
- Improved plant operability
- Reduced number of plant shutdowns with an improved control narrative
- Troubleshooting for process upsets
- Insight for start-up and first plant operation before actual plant commissioning
- Safer designs and identification of potentially undersized equipment (pumps, compressors, valves) before commissioning and first plant start-up
- Assessment of existing facilities to check if they can accommodate new productions
- Improved workforce expertise with comprehensive learning resources
- Best practice

With reference to a recent case study based in Central America, Inprocess engineers provided consultancy to a large owner-operator, whereby we were asked to verify and perform a feasibility study on engineering design models supplied by an international EPC. Verification of the EPC's design formed the project's first phase while its second involved verification of the multiphase pipeline behaviour, assessing plant start-up and support plant operability to reach production targets.

The project involved analysis of all operating variables, including safety analysis, process dynamics and units interactions. Applying simulation models helped our client across different phases of the facilities' lifecycle. In phase one, using AspenTech's Aspen HYSYS, first-principle models (steady-state and dynamics) provided a significantly better understanding of the process dynamics and its interactions and enabled our engineers to evaluate and fine-tune strategies before implementation. Aspen HYSYS is the interface to build complex models process plant. Using dynamic simulation early in the design phase allowed our engineers to identify important operability and control issues, along with equipment sizing adjustments, which led us to improve the design.

Through the second phase, the Aspen HYSYS simulation platform integrated everything into one simulation environment, reducing the time required for "what-if" studies. During start-up operations, a holistic simulation model, incorporating both the pipelines and the structure of the platform (topside), determined the correct sequence of steps to adopt when starting up the initial wells and to reach the early production rate. Designing pipeline systems require complex considerations, such as the pipeline flow path, terrain profiles, expected volumes to be received and delivered over the pipeline, along with the physical properties of products to flow through the pipe. Dynamic simulation of pipelines with updated compositions from the wells was invaluable to gain crucial information about the development of liquid holdup profiles, as well as pressure and temperature data. This information determined predicted hydrate formation risk and slug sizes. Crucially, dynamic modelling results helped in keeping the flow going, which consequently prevented interruptions to the plant and avoided reduced profits.

Big savings were achieved on the project through improved and faster start-up procedures with capital cost savings through the avoidance over-design of relief systems. The topside model was tuned and calibrated by reconciling discrepancies with plant data, by adjusting certain values and parameters to ensure the model corresponded to actual unit operation before proceeding with further development.

The availability of the upgraded model helped our client troubleshoot operability issues and to reach targets earlier. In addition, using a common platform facilitated the effective communication between all stakeholders, which was essential for the transfer of knowledge. Collaboration and information sharing became the lifeblood for determining accurate outcomes and analysing plant behaviour.

Inprocess also delivered a Process Trainer of the plant. This is the updated dynamic model containing real plant data, combined with a user-friendly interface, identical to the HMI of the plant that facilitates the execution of pre-programmed scenarios of different operational conditions to troubleshoot detected problems. In the early field production phase, this operational support yielded a database of operational cases, which are cumulative during the plant life cycle. Consequently, newly-hired engineers (and operators) are able to learn how the plant operates by following the simulation cases, helping also to minimise the impact of personnel turnover in plant operability and safety.

## Confidence in operational outcomes

An effective design and control strategy requires a comprehensive understanding of the process in order to successfully avoid unplanned downtime. The use of cutting-edge software is essential to support engineers through key stages of a project and help with knowledge, collaboration and learning. Process simulation experts can now quickly create robust models that can validate EPC design and increase confidence that projects will run on time, to standard and be maintained easily resulting in optimised operations. Dynamic models of the plant give companies the assurance that they can achieve faster and safer plant start-ups whilst maximising productivity.

From our experience, dynamic simulation avoids disruptions and minimises the impact of unnecessary costs on real plant operations. For instance, using a reliable dynamic model, owner-operators can ensure the achievement of production goals according to already signed contracts, avoiding penalties for not meeting either agreed production or product quality. Similarly, they can plan for sub-optimal plant operating points, preventing full plant shutdowns and keep the plant in operation, for instance when partial power failures occur in remote locations and where power supply can be very unstable. The reality today is that owner-operators and EPCs can enjoy tangible benefits that deliver a realistic understanding of plant behaviour and, ultimately, achieve significant savings.

Written by Miquel Angel Alós, PhD, Inprocess.

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