The last few years have seen a growing focus on integrated production management. Yet, too often, there is a lack of integration between the two disciplines of production and reservoir engineering. Such teams often tend to work in different domains with different workflows and only share information when they have to.

This article argues that a future vision of integrated production management can only be solved through a closer software link between production management and reservoir engineering and a fully integrated workflow across the lifecycle of the field.

Integrating production and reservoir engineering

Last year Emerson Automation Solutions acquired Norwegian company Yggdrasil. Emerson is incorporating Yggdrasil's production optimisation solution into its Roxar reservoir management software portfolio.

This acquisition is a step forward in integrating the disciplines of production engineering and reservoir engineering, where the daily management of oil and gas production is combined with reservoir modelling, uncertainty quantification and simulation data to help operators optimise their field development and production plans.

The new software – known as Roxar METTE™ – includes network optimisation, well performance, transient simulation and virtual metering capabilities as well as built-in interfaces to reservoir simulators.

Such elements are central to an integrated production management system.

Network optimisation focuses on the production and surface facilities network from well inflow to processing facilities, enabling operators to find operating points that maximise hydrocarbon throughput via subject or defined constraints. ‘What if’ simulations can also be carried out.
Well performance concentrates on the capabilities of the well in delivering oil and gas – in particular profile data, gas lift hydraulic analysis, and vertical flow performance (VFP) tables can be created. Components such as compressors, pumps and choke valves can also be modelled and well or flow lines capacities can be simulated using multiple boundaries to quantify the effect on production potential.

Transient analysis is used for the time dependent simulation of well and flow line behaviour. Applications where the transient module in the METTE software can be deployed include cool down times for different pipe wall insulation configurations, the calculation of the necessary hydrate inhibitor amounts during cold start-ups, and the evaluation of required times for flow line depressurisation.

Finally, virtual metering provides a cost-effective solution for determining well phase flows through the interpretation of primary flow related field data, such as measured pressures and temperatures.

**Bridging the gap**

It is in bridging the gap between production and reservoir engineering that METTE plays its most significant role, however. This can be seen in the network simulation module – an advanced engineering tool for single and multiphase flow systems.

By directly connecting to reservoir simulators, the software provides concept-dependent production profiles, with reservoir outtakes reflecting production targets and constraints in the downstream production network.

This capability allows for the seamless simulation of hydrocarbon flow through the reservoir production system to a processing facility. This provides life-of-field (LOF) variations in mass and energy balances to be modelled and optimised power, gas lift and hydrate inhibitor usage.

It also determines well routing, the effect of pigging and scheduling for infill wells or third party tie-backs, and the quantification of the effect of pressure boosting equipment.

When coupled to reservoir simulation processes, the production network feeds guide rates back to the reservoir processes for the next time step with the guide rates reflecting current production system capacity.

The production network can be interfaced to service networks for lift gas and/or continuous hydrate inhibitor distribution, with all networks being solved in each time step. Constraints in the service network(s) will also be reflected in the production network.

Well inlet boundary conditions in the network can also be derived from completed, coupled reservoir/network simulations to provide ‘proxy’ reservoir models. Using proxies for well boundary conditions and life of field simulations can be carried out very quickly, lending itself to parametric studies for everyday engineering work.

**Other reservoir engineering links**

There are also other ways in which the new software links in with reservoir engineering tools.

For example, virtual metering results can be used with reservoir model history-matching as well as for daily or historical production allocation. The combined virtual metering and forecasting capabilities add up to a powerful production management tool.

Furthermore, with the close integration of the software with Emerson’s existing reservoir engineering solutions – its reservoir simulator MORE and history-matching and sensitivity tool ENABLE – an effective tool is available for production forecasting and optimisation.

**Two North Sea fields**

Examples of integrated production management and METTE can be found in two North Sea fields.

In the first case, the software is being used as a flow assurance tool on a medium size oilfield in the North Sea, comprised of three different reservoirs requiring artificial lift in the form of gas lift. A large number of development alternatives were screened in the early phase to create concept dependent production profiles.

To provide consistent LOF data, the software was used to perform coupled simulations, interfacing the three separate reservoir simulation models with gas lift optimisation. The production network model was simultaneously interfaced with a gas lift supply network to determine its variation in mass and energy balances. Using decline curves that originated from these simulations, the effects parameter variations, such as flow line and tubing sizes, were investigated to find optimum sizes based on reservoir model predictions over field life.

The second application is in a marginal North Sea oilfield with a heavy non-Newtonian fluid that required artificial lifting. In this case, the software provided functionality for the use of shear dependent viscosity data during both steady state and transient simulations.

Decline curve data from the reservoir simulation model was used as input to a production network model, which was then used to predict artificial lift times, together with system lifetime mass and energy balances. These used two alternative lift methods in the form of electrical submersible pumps and gas lift.

The strong gelling tendencies of the production fluid also required the implementation of experimental yield stress data to perform realistic transient start-up simulations of the wells and flow lines. The development concept also included simultaneously water alternating gas, (SWAG) for gas reinjection into the reservoir, simulated by the use of the software.

**A new approach**

Operators today are looking for a workflow that integrates production and reservoir engineering to provide a complete picture of the field. They are looking to align their modelling, uncertainty quantification and simulation data with production to optimise their field development plans and increase recovery.

With software solutions, such as Roxar METTE, operators are well on the way to achieving this.