

Aspen Tech User Group Meeting October 2003 – Paris

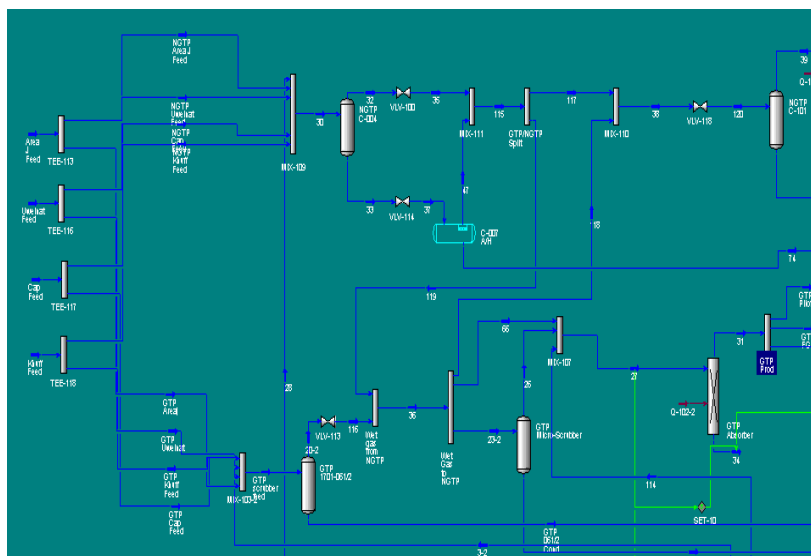


Figure 1 HYSYS model¹

Aspen Tech's products span manufacturing, supply chain and, within oil and gas, are predominantly focused on refining². Our report is from a relatively new facet of Aspen Tech's activity. Subsequent to the acquisition of HyproTech last year, Aspen Tech has a firm foothold – in fact a near monopoly if the FTC is to be believed – in upstream process control and modeling software. Judging by the relative attendance (about 30 attended the upstream session) this technology is still of limited reach. A new initiative—the [Upstream Advisory Board](#)—sets out the give wider exposure to these techniques. Of note also is Schlumberger's involvement on the Board.

Aspen Tech's offering is at the heart of the 'e-field' concept—where increased data monitoring and information technology are combining to enhance production. Significant technology transfer is underway from refining (where simulation/optimization is used on a regular basis) to the upstream. There is an inevitable culture clash due to differences between process modeling at the refinery and modeling the reservoir. Refiners model processes they understand. Any discrepancy between the model and the facts can be fixed by looking at some of the plethora of measurements of the process itself. Reservoir modeling is the poor relation of process modeling. Here parameters are tweaked so that the model fits a limited data set. 'History matching' is widely used to establish the model in what has been a rather unscientific fashion. In reservoir modeling, a rough and ready categorization of fluids as 'black oil' replaces the full compositional measurement of the refinery. Modeling which spans the two domains needs strategies for mapping from one 'world-view' to the other.

Generally, while simulation promises real-time operational production enhancement, operators have proved reluctant to drive assets harder than traditional procedures allow. The modeling community has some way to go to convince engineers that real time optimization¹ can be achieved safely. Today, the role of modeling is mostly limited to plant design. But few doubt that real-time optimization—and the 'e-field' are just around the corner.

¹ Image courtesy AspenTech

² In a recent report by [ARC Advisory Group](#) the "Process Simulation and Optimization Worldwide Outlook," worldwide shipments of Process Simulation and Optimization (PSO) software and services, which exceeded \$338 million in 2002, are forecast to reach \$500 million by the end of 2007.

Highlights

[BP – production optimization](#)

[ADMA – modeling the big picture](#)

[Schlumberger - Reservoir and facility simulation](#)

[Upstream Advisory Board](#)

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Plenary session

Lee Riley welcomed the 400 plus attendees from 48 companies and 29 countries. 60% of attendees came from the engineering community – with the remainder from modeling and simulation.

David Quillan provided an update on AspenTech’s financial position which is ‘becoming financially strong’ – with improved financial performance, a new \$100 million line of financing and the company is now net cash positive³. Quillan commented that the last twenty years has seen significant investment in ERP systems. But the future will bring a move away from these transaction-oriented systems and will see integration of the two different worlds of finance and engineering via the enterprise portal. Aspen Tech

³ Aspen Tech revenues for the first quarter 2004 (ending 30th September 2003) were \$77.0 million, with software license revenues totaling \$35.1 million, and services revenue totaling \$41.9 million.

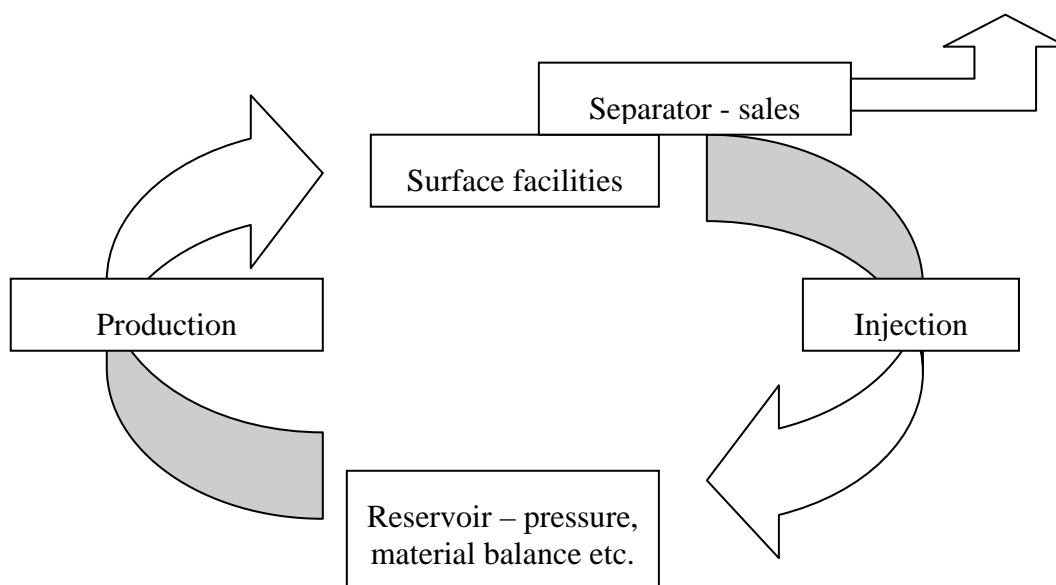
itself is not in the portal business – but will be providing tools within the portal. Along with Aspen Tech’s engineering and manufacturing tools a new ‘operations cockpit’ will leverage technology from Accenture, Microsoft and Tibco and will offer a solution tailored to each vertical industry.

Aspen Tech founder **Larry Evans** believes Information Technology projects offer a high return on investment for a low cost and risk. Evans stated that up to \$500 billion ‘economic potential’ is lost through bad decisions which could be avoided by ‘operational excellence’. This is to be achieved through modeling and IT-based decision support.

Production optimization with rigorous simulation models - Bryn Stenhouse, BP

Stenhouse is in BP’s E&P Tech (UTG) and provides central support in BP to study simulation/optimization (SimOpt) applied to a ‘plant’ i.e. a production facility. SimOpt technology comes from refining. Stenhouse is trying to persuade upstream operators to try/use SimOpt but there has been some skepticism, where daily ‘fire fighting’ is more of an issue.

SimOpt – the big picture



The scheme is valid onshore, but more usually applied offshore where although the potential benefits are higher, access makes things difficult. Unsteady state operations are common, making the use of steady state models questionable. Limited data availability makes production SimOpt different to refining - where there are ‘at least two measures of everything’. Data reconciliation can be problematical. A learning for new plants has been to convince project designers to put meters in plant and use more sophisticated downhole instrumentation. This is a multi discipline activity – reservoir management, well performance, surface and commercial issues at play. These are especially complex in the gas business. A multi disciplinary tool is required for such modeling.

Case history – Pompano GOM asset

This 40K bpd mature asset is not equipped with fancy new technology – ‘you’ve got what you’ve got!’ Platform and subsea tie-back cause wobbles with slugging. Pressure back off is mitigated across wells. An optimization study was performed with [MDC](#) (Emerson) using EPT’s modeling tool. The optimization problem revolves around which wells to flow to which pressure header and which to choke back. Other issues include oil/water/gas management, gas lift and compression. Note that the development is not a real time application – more intended for offline decision support. Scoping showed a

clear opportunity to reduce gas lift to some wells to optimize production. This is a ‘classic’ coupled problem between facility and well–related variables.

Pompano – division of labors

EXCEL	HYSYS	GAP
Excel model built by MDC to control HYSYS and GAP opposite. GAP is embedded into HYSYS and shares variables.	Topside	Petroleum Experts tool for well performance optimization (GAP aggregates Prosper models which are ‘very popular’ in BP)

Case history Valhall optimization

Valhall is a mature North Sea asset producing 100kbpd from 38 wells. Two HP/LP compression trains with 7 stages of compression reflect incremental design creep and are perhaps the most complex facility ever! Process from remote tie-back again demonstrates slugging. The study was performed by MDC. Valhall benefited from a good infrastructure for online optimization with good bandwidth and metering. MDC could observe operations in real time. The complex constrained compression system was the target for optimization by making space for production in the compression system. A tax on produced CO2 was also an issue. The optimization boiled down to 6 numbers that operators need to track. Success factors included accurate asset models of wells and facilities based on tools of choice: Pipesim, HYSYS, Prosper GAP. A consistent data set for validation was also key. Optimizing linked black oil and compositional PVT models was a non trivial problem – models need to be ‘robust and available’ since optimization cannot halt operations. People and process proved more complex issues due to the cross-disciplinary nature and ownership of the project.

In fact both of these projects have ‘struggled’ to provide value for BP because of people issues. Valhall optimization potential is significant–but operators have not taken much notice because the project did not have buy-in from day one. The reaction tended to be ‘very interesting–now let me get on with my job⁴.’ The Valhall control room is moving onshore and it should be easier to manage optimization. Operators need training and there needs to be a clear offering – perhaps a performance contract including a 2% production hike. SimOpt needs to be delivered ‘at pace’, worldwide and for multiple assets. There is a need for ‘plug & play’ models integrating technology and commercial issues. Steady-state and dynamic in one model, Smarter optimization [MINLP⁵](#), analytical derivatives and ‘models that answer questions that have not been asked yet’ are aims.

Q&A

Q – Is the reservoir modeling community involved?

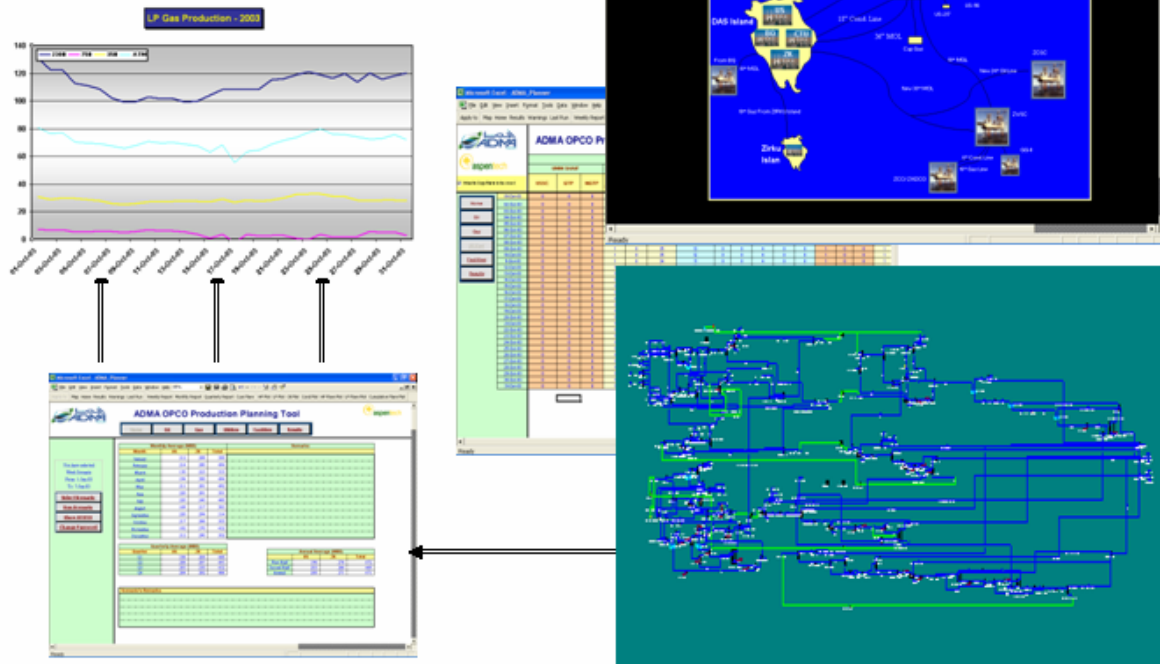
A – Yes, we talk to them although the timescale is different. It is an interesting dialog but we really need a new tool to optimize across different disciplines and time scales.

⁴ Stenhouse also indicated that operators were concerned with potential gas blow-by as assets were driven closer to the edge.

⁵ Mixed Integer Nonlinear Programming.

Marc Cochrane – ADMA – OPCO

ADMA – OPCO System Architecture

Figure 2 ADMA-OPCO system architecture⁶

ADMA is operator of about half of the United Arab Emirates' (UAE) production. Production goes to a central facility on Das Island. Environmentalism became an issue in the 90s and by year 2000 was serious. Flaring gas for production is now tightly regulated. In 1992, \$100 million worth of gas was flared. In 2002 this was down to \$6 million. Flare reduction studies used to be run on Excel. This has now been ported to Hyprotech and a year of production can be modeled in under an hour. Low pressure gas capture is critical at the DAS island facility. There is a lot of slugging in low velocity lines.

Ahmed Hamdan presented the ADMA OPCO Production Planning Tool (PPT) including:

- HYSYS – steady-state/dynamic model of process facility
- Profes – transient pipe model
- Excel – integration and data I/O
- Visual Basic – glue for all of above

HYSYS – uses first principle thermodynamics

- essential for system performance
- integration to PPT interface – user doesn't know it's there
- comprehensive models for Umm Sheist Das and Zakum
- validated individual models @ < 2%

⁶ Image courtesy ADMA-OPCO

GUI – The Excel front end allows for selection of planning scenarios, data entry and result display. A tree view allows for selection of products, flaring, reports and ‘canned’ plots. Warning messages flag flaring, excess capacity, non-convergence etc.

Figure 3 HYSYS Model⁷

ProFes – pipeline transient simulation

- 5 transient ProFes models to study behavior.

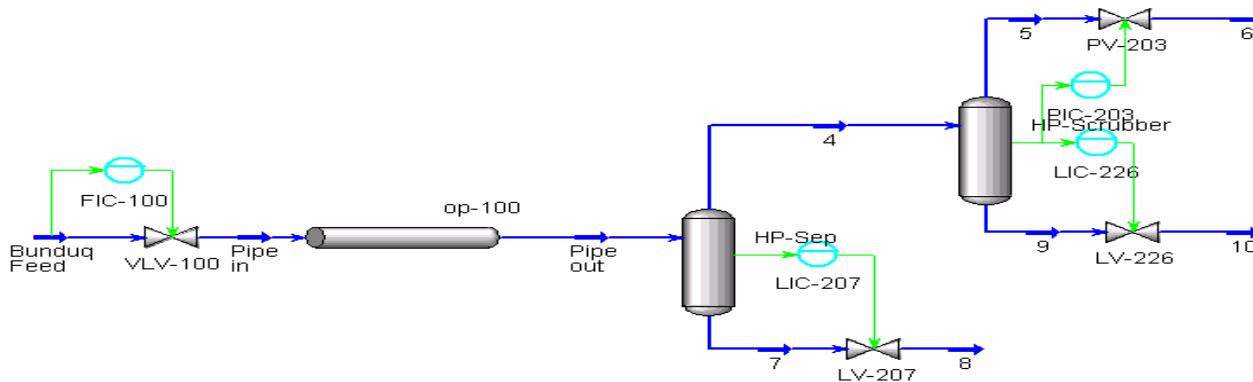


Figure 4 Profes pipe simulator⁸

Profes models allow the user to perform slug analysis, line pigging, and compositional tracking. The pipelines are integrated within the facilities models allowing the user to study different control problems, scenarios and troubleshooting. Success factors were the close interaction between the ADMA project team and AspenTech, flexible financing. The fact that the service provider is also the developer meant that the link between ProFes and HYSYS could be developed. ADMA and AspenTech have shared the value of this simulation optimization.

Q&A

Who uses it?

A – Production planners. By the way this project has been a ‘glorious success’. It cost \$500k and resulted in a 2% reduction in flaring, paying out in 6 months. It is also adaptable; new HYSYS models can be plugged in. The model is now being used for optimization.

How accurate are the forecasts?

A – For prediction, the absolute results are ‘shaky’ but the trends/direction indicated are good. This is work in progress. Currently only modeling topsides, next will be wells and then reservoirs. In 5 years we will be modeling the whole process.

Dynamic Simulation in oil and gas modification projects - Truls Larsson, Aker Kvaerner

Aker Kvaerner (AK) has 2,400 employees including 1,000 engineers and a 2.5 bn NOK turnover. AK is involved in all processes of field life and has used HYSYS for dynamic simulation for the last couple of years. Larsson’s thesis is that static modeling can produce overly conservative results and may indicate

⁷ Image courtesy ADMA-OPCO

⁸ Image courtesy ADMA-OPCO

high risks of gas blow-by⁹ choke collapse and poor valve operation. Only with a complete dynamic analysis can the true optimization potential be realized. Conventional station analysis based on API RP 521 is satisfactory for a new build. But in a typical modification project the PSV (pressure release valve) is already sized. Here, dynamic analysis can be complex. But a peak pressure which is 10% lower than the static case may make the project feasible.

Dynamic Simulation of gas plant pressure control system - Claudio Mestichelli, ECOS group.

ECOS Engineering has some 60 process design engineers and billed 100k man-hours in 2003. ECOS uses various HYSYS modules along with some in-house developed tools. This paper presents the dynamic simulation of an oil and gas plant pressure control system. The system includes the well head, production manifold, separator, CO₂ removal 'hold-up' model and a high pressure elevated flare manifold. The project set out to select control philosophy – feed-back or feed forward – to analyze and predict plant behavior on upset conditions (e.g. shut down). All without stopping oil production. The main focus was the upset condition when the downstream gas station can't receive gas (because of no demand) and issues relating to the CO₂ removal unit shut down. A CO₂ unit shut down simulation showed upstream pressure build-up; the control system cuts in. A time graph shows pressure rising and falling as wells shut down. Controller parameters can be tuned to keep production on-stream. The emergency shutdown system parameters can also be fine-tuned. But the study recommended that a valve on the CO₂ unit should be changed to 'quick opening'. This allowed for a CO₂ unit shut down, gas flare kicking in and oil production keeps running with the plant remaining in spec.

Q&A

Did you consider putting a derivative action on controller?

This will be studied later.

Why can't you save run parameters in HYSYS?

This will be addressed. We are learning a lot from Aspen dynamics. There will be a new dynamic initialization option in HYSYS 3.2

The future of reservoir, well, production and facility simulation - Steve Miller, Schlumberger Information Solutions

Miller told of a plan 'hatched in a West London pub' to link Baker Jardine¹⁰ and HyproTech's¹¹ tools into a 'total production system.' The first issue was the problem of the silo mentalities. Reservoir simulations may be run with well and group controls but modelers don't actually talk to facilities engineers. There is a tendency to optimize components, not the whole system. At the same time, everyone is 'drowning' in data of different formats and provenance. Data management for a small but well-instrumented field may involve 7000 data points/day. In other words, 27x10⁶ points through life of field (every 15 minutes).

PIPESIM models wells and connections. This links in to the reservoir engineering domain Open Eclipse. A new 'Open Eclipse' functionality allows Eclipse to be controlled by an external application. Field planning events can be built in to the model and displayed as time-based data. A graph showed coupled time steps across the reservoir model, compressor, pipe etc. PIPESIM can be driven from real time data from the field to run the model automatically and to establish new set points for operations.

Electrical submerged pumps (ESP) are often used in modern production for gas lift and high water cut – but they increase downhole temperature leading to topside constraints such as routing of hot wells through

⁹ Gas flow in liquid line.

¹⁰ Baker Jardine later became part of Schlumberger.

¹¹ HyproTech became part of AspenTech.

different separator trains. Miller described early attempts to model these processes in Excel but warned that such developments may prove hard to maintain. Schlumberger's solution was to take industry leading apps & provide connectivity. In 2001 a single branch link PIPESIM solver was embedded in HYSYS. The next step is full field modeling with a HYSYS/PIPESIM - Net interface which integrates a complete network of wells and flowlines to a HYSYS simulation. This provides full field-wide simulation, screening, product optimization etc. Variables such as choke size, gas lift, ESP power etc. can be set according to constraints of temperature, pressure, water handling capacity and compressor power.

In the future, a new product, the Medusa Field Planning Center, Schlumberger will offer complete asset data management over a common data base. This will link Eclipse to field planning and optimization technology in Aspen's AssetBuilder.

Q&A

Is the link to PipeSim dynamic?

No it is steady state.

Do you plan to model pipes in ProcessSim?

PIPESIM model can be put anywhere in HYSYS model. PIPESIM is a general purpose network solver.

Not all system components will necessarily come from Schlumberger. How open is the environment to third party applications?

Schlumberger develops Open Systems; Medusa will tie to other vendor applications through the Open Eclipse development kit. PIPESIM has a documented Open API for third parties to write links. But Schlumberger wants to provide more direct integration with leading tools.

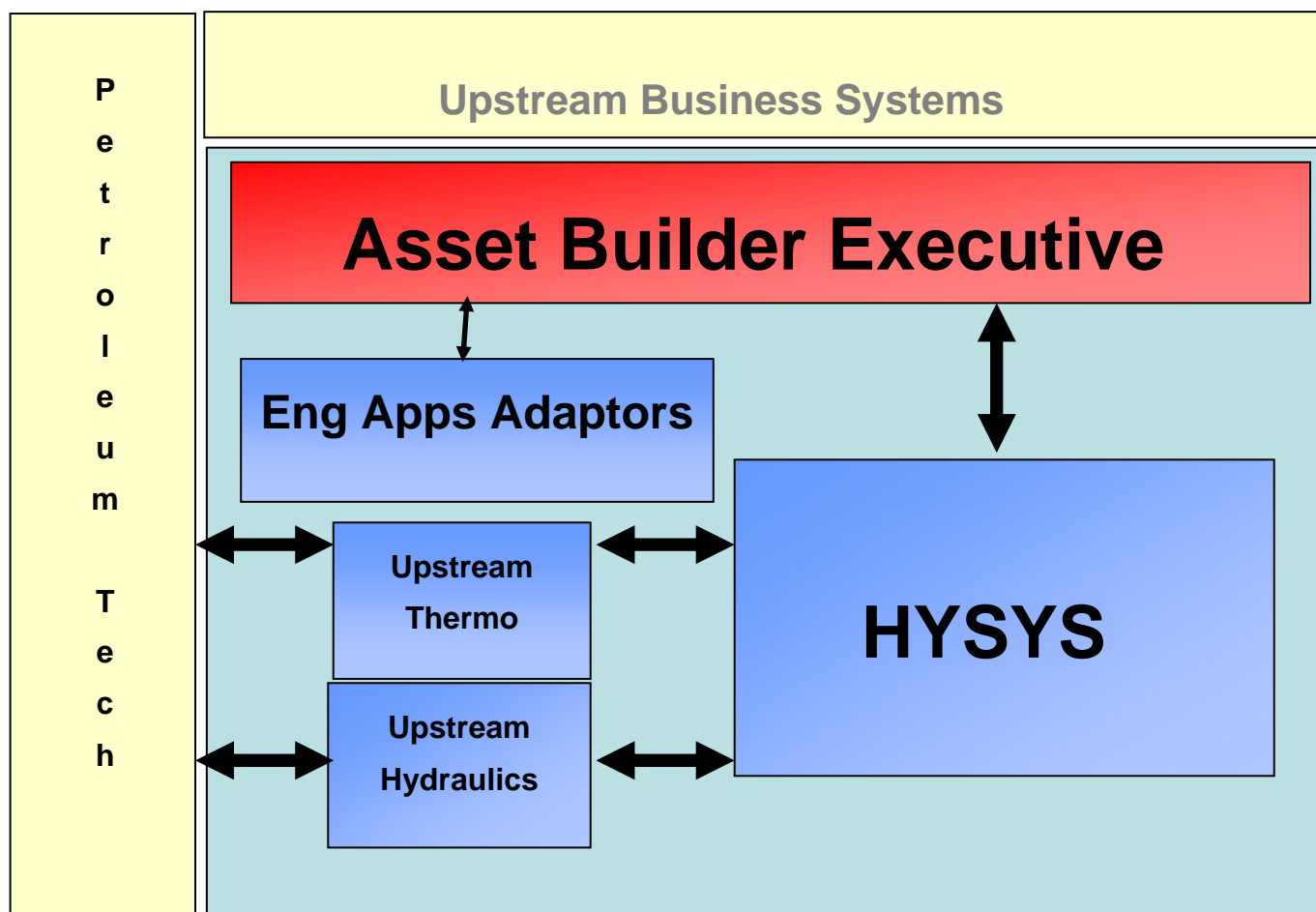
To what extent are Schlumberger and Aspen competing in this space?

More complementary than competitive. We are looking forward to sharing databases and to providing domain aspects to our tools – providing appropriate workflows for different users.

HYSYS Upstream Option - Brian Wood, Product Manager

Look to increase ROCE – daily/monthly summaries may contradict slow loop production. The problem (again) is one of silos; petroleum engineering, production engineering and facilities. The new HYSYS Upstream Option targets these issues by integrating production engineering, facility engineering and hydraulics.

HYSYS Upstream Option

Figure 5 HYSYS Upstream Option¹²

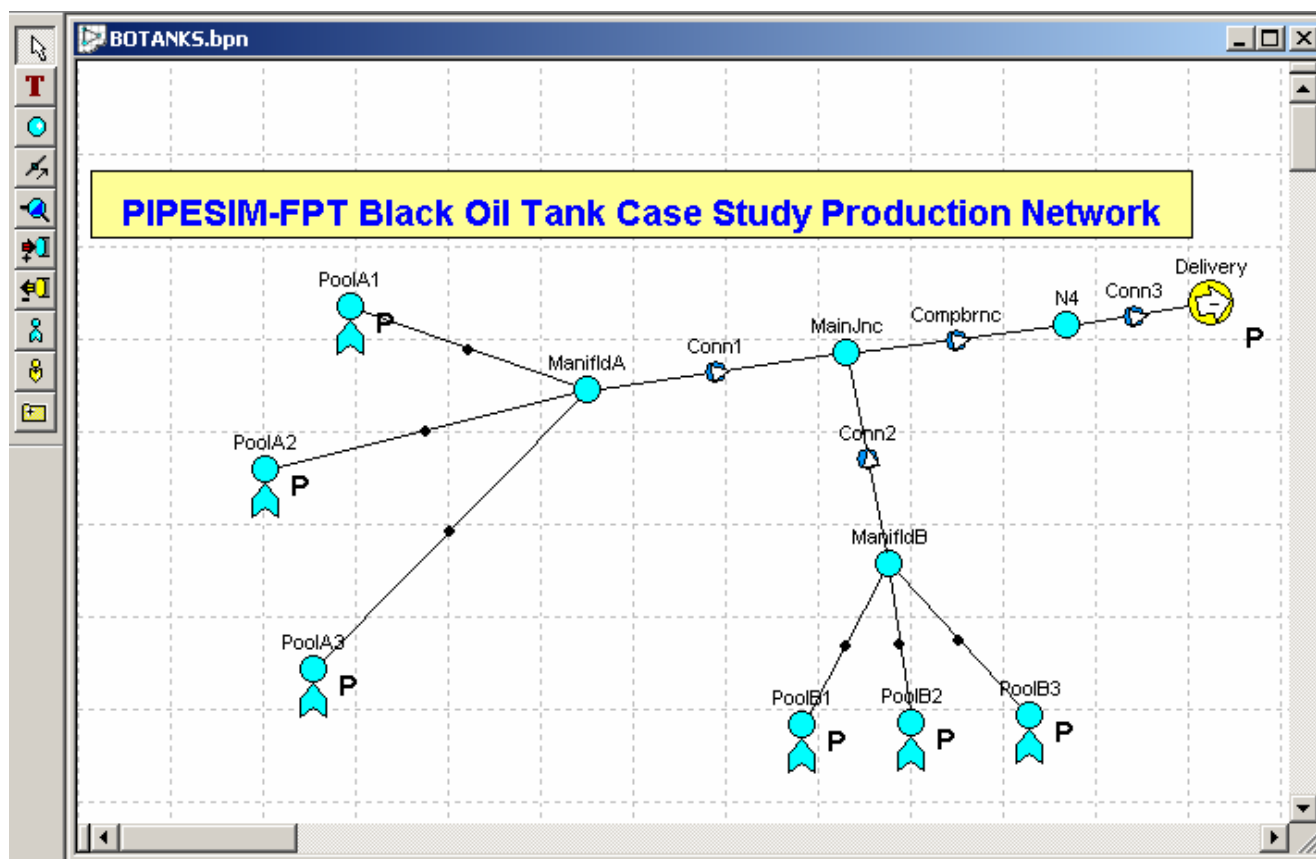
HYSYS Upstream V 3.02 was released October 2003. A key difference between upstream reservoir simulation and process modeling is the concept of black oil. At the reservoir and during production, full compositional analysis of fluid is rarely available. Produced fluid is characterized as 'black oil' associated with a gas oil ratio and water cut. In process modeling, full compositional analysis of C1, C2, C3 etc can be made at any point in the process. To interface reservoir and process modeling, a concept of lumping and delumping is applied. Reservoirs with black oil only analyses and others with full compositional data can be studied together by lumping as the process is studied downstream and by de-lumping back upstream. Neotec's Black Oil Methods and Infochem's 'multi-flash' PVT analysis are embedded in HYSYS Upstream and provide cookbook methods for characterizing blends into 'pseudo components' for lumping. These techniques can also be used for production allocation techniques.

Success story – Paragon Litwin & Burlington Reosources. Dhaharmakari – MLN field, Algeria. This project was presented at Aspen World 2002. 50% of the project effort was spent on validating compositional data. Now this is automated and production has increased by 500,000 bbl/year.

Wood also showed HYSYS – PIPESIM-NET integrated simulation of a gas plant working with three gas suppliers. PIPESIM components can be dragged and dropped onto the model. Wells added with productivity index, completions, tubing and flowlines. These are grouped into the simulator¹³.

¹² Image courtesy AspenTech.

¹³ All involving a large amount of tabular data entry.

Figure 6 HYSYS PipeSim Net¹⁴

The Integrated Asset Model – Andy Howell, Oil & Gas Director AspenTech.

The combination of Visual Basic and Excel is ‘a great tool for visualization’ but is not to be recommended for building mission critical applications. Work done for clients including NAM and BP has led to the development of Asset Builder – which was ‘3 years in the making’. What began as a chemical engineering problem has become a data/IT issue. All companies have different views of their problems and data and of how integration will contribute to the Digital Oil Field realization– these must be managed before addressing optimization.

AssetBuilder stakeholder operators work in a highly deregulated oil & gas business with many stakeholders – land owners, the pipeline company, gas plant, refinery etc. Everyone shares a bit of everyone’s contract. Upstream simulation is actually quite simple – but connecting the whole thing together across assets and operations is very complex. Maximum flow rate does not necessarily equate to maximum ROI. Third party well models can be deployed as well as MINLP Solvers LP Vector Update. One possibility was to roll all these components into one single application. But although this might be desirable, the silos want to use their own tools. So Aspen created Asset Builder (AB – a working title). This is described as 99% IT and 1% engineering – mostly Microsoft .NET and XML. Currently AB is steady state, the next version will be dynamic. AB uses publish and subscribe technology with XML and .NET. This has evolved from the OLE/DDE environment¹⁵ into a tag data server supporting data drag and drop. A tree view displays currently available HYSYS cases to connect. Even real time videos of assets can be incorporated – ‘it’s important to provide the view of the asset as seen daily by client/user’. Because ‘you’ll never get away from Excel’ – so this has been embedded into HYSYS. AB has its own

¹⁴ Image courtesy AspenTech.

¹⁵ A Visual Basic ‘industry’ has evolved around HYSYS. This will have to go!

Document Management System but works with Microsoft SharePoint Server or Documentum. Time stamped results show who did what and when in the integrated asset model. HYSYS now performs full compositional output and is no longer limited to black oil. MINPL genetic algorithms developed for polymer production are available for optimization of oil and gas production and contracts. Aspen's MIMI supply chain integration technology has been used for gas lift optimization – which Howell described as the 'low hanging fruit' for product optimization.

Q&A

What of XML use in integration?

Other XML (.NET) adaptors and database query technology from vendors such as TIBCO, Labrador and SSI can be used to plug AssetBuilder into production database applications like Schlumberger's Finder.

Is the main use in optimization or planning?

AssetBuilder can be used to create an Integrated Asset Model for daily optimization and field development planning. Aspen has a whole suite of optimizers used in downstream. For Upstream we need to choose the best – so that the optimization can perform when wells go down and equipment is removed for maintenance. HYSYS also has the ability to plug neural network technology into AssetBuilder and perform gas-lift optimization with Schlumberger's PIPESIM-NET running a parametric model in seconds – but if a sector of the gathering system goes down, neural networks can fail – so the neural network selector and event manager in AssetBuilder can be used to maintain robust optimization.

Upstream Oil & Gas Advisory Board – Andy Howell, Brian Wood, Marcela Aguirre

The Upstream oil & gas advisory board is a new Aspentech/Hyprotech venture. AspenTech is inviting Operators and EPC companies to 'shape the way forward' in collaboration with the 'Schlumbergers of this world'. The next meeting is scheduled for Feb 4th in Calgary. The plan is to associate Schlumberger and other third party vendors with Oil industry experts and shape the way the simulation and optimization market develops to support the Digital Oilfield. A lot of Canadian companies are interested along with Shell, BP, ExxonMobil and ConocoPhillips. Saudi Aramco also is very interested.

AspenTech Product Backgrounder¹⁶

- *HYSYS Upstream uses industry proven methodologies to predict the behavior of the production fluid and integrate the reservoir characterization with the process facility simulation. Since accurate compositional analysis in the reservoir or at the wellhead is rare, leverage the two main industry methodologies used by petroleum and production engineers – Black Oil Thermodynamics and PVT Analysis – both provided by industry-leading technology companies in this area. Use a standard hydraulics data model for the integration of industry hydraulic applications into process simulations. Analyze hydraulic systems with a consistent topology definition of the network with any third party steady-state or transient flowline code. Integrate, within HYSYS, flowline simulators such as PIPESIM-NET from Schlumberger.*
- *FLARENET. Design, rate and debottleneck single and multiple flare and vent systems. Calculate minimum sizes for new flare systems, or screen alternatives to relieve bottlenecks in existing networks. Identify dangerous relief scenarios during design phase while demonstrating regulatory compliance of plant flare and vent systems.*

¹⁶ From AspenTech product sheets.

- *ProFES 2P Tran / ProFES 3P Tran / ProFES Tranflo. Model steady state and dynamic behavior of multiphase flows in wells and pipelines. Account for two-phases, sand and slugs. Economically size pipelines, separators, slug catchers, and other equipment by modeling liquid and gas surges. Optimize startup, shutdown, and injection and depressurization rates. Predict behavior of complex three-phase oil, water, and gas flows. Provide solutions for systems with high water cuts, oil-water segregation problems, or vulnerability to corrosion.*
- *HYSYS PIPESYS. Accurately model single and multiphase flows to design, debottleneck, and optimize pipeline systems. Account for pipeline elevation profiles, inline equipment, pipe composition and roughness, and fluid properties. Model networks with multiple flow paths. Perform forward and reverse pressure calculations. Compute detailed pressure and temperature profiles for onshore and offshore systems. Perform sensitivity calculations for system dependencies.*
- *HYSYS OLGAS. Use industry-standard pipeline and well bore sizing correlations within HYSYS. Calculate pressure gradients, liquid holdups, and flow regimes.*
- *Aspen AssetBuilder is an integrated asset model and supervisory system that lines up multiple HYSYS simulation cases and connects them to field decline curves, well network simulations and optimization and time stepping. Aspen AssetBuilder enables full integrated visual asset models to be used and maintained.*

[Technology Watch Service](#)

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