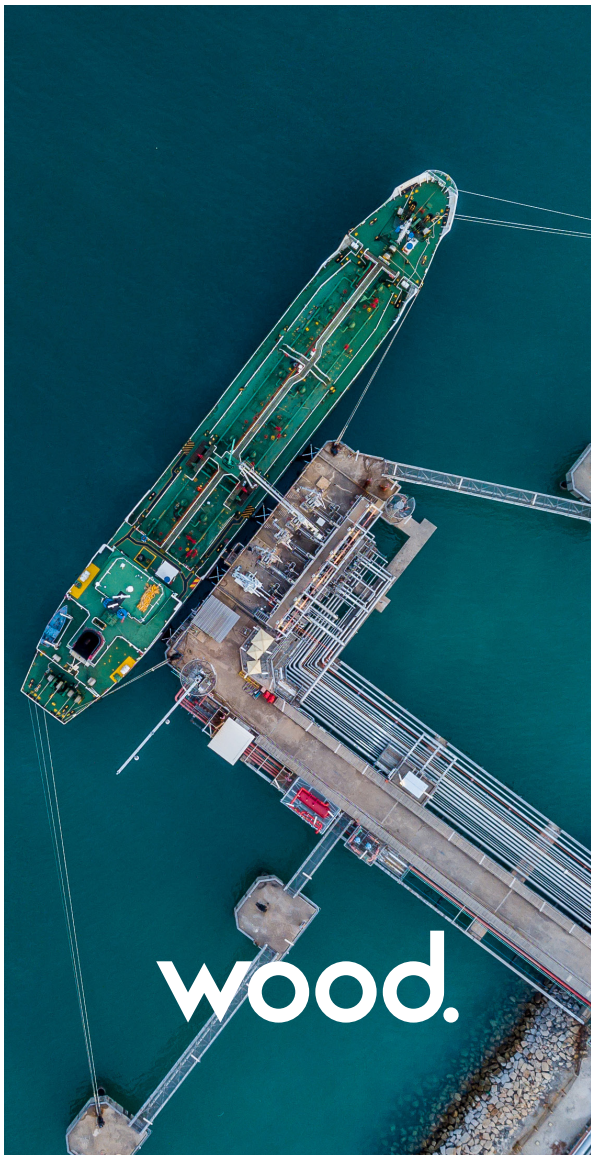
Virtuoso®

Industry leading engineering simulators, operator training systems and online monitoring systems



Production, pipeline & asset management systems

Wood provides robust, real-time online and offline software systems for the efficient management of oil and gas operations.

Virtuoso®

Virtuoso® is a field proven suite of software products, with more than 20 years' successful track record of performance in the field. Our technology supports engineering studies, operator training and simulation wells, pipelines, and processing facility operations onshore and offshore.

For example, Virtuoso is used to help manage some of the world's key gas resources, supporting 10% of the global consumption of this vital commodity.

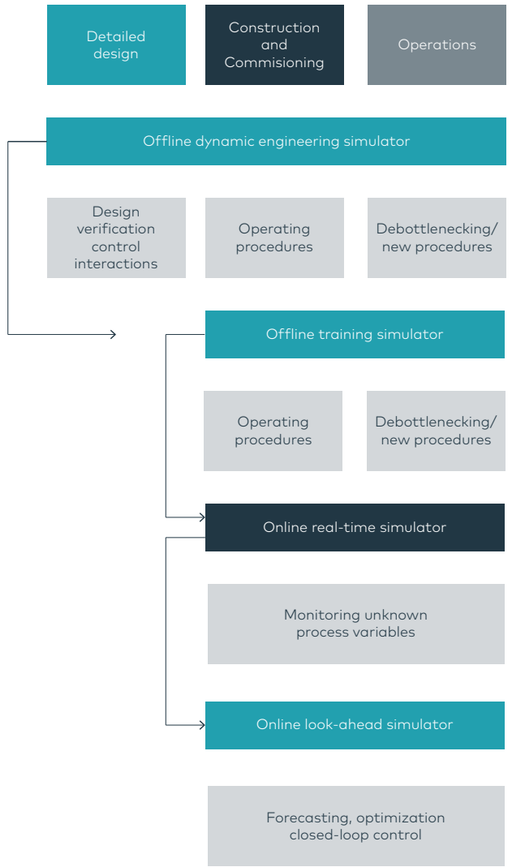
Our software products provide essential operational and commercial functionalities based on the unique challenges specific to each customer project. We address the most complex single and multiphase gathering, productions, transportation, and processing issues with our technology solutions.

The Virtuoso software suite includes offline packages such as:

- **Virtuoso/ES** - Engineering simulator
- **Virtuoso/OTS** - Operator training system

The online packages include:

- **Virtuoso/Monitor** - Operations monitoring
- **Virtuoso/Advise** - Operations advisory
- **Virtuoso/LDS** - Leak detection system
- **Virtuoso/Control** - Operations control
- **Virtuoso/Optimize** - Operations optimization and planning
- **Virtuoso/VMS** - Virtual metering system®
- **Virtuoso/Analytics** - Data analysis and processing
- **Virtuoso/EOR-SAGD** - steam-assisted gravity drainage (SAGD) operations
- **Virtuoso/Flare** - flare system monitoring



Offline applications

Virtuoso/ES (Engineering simulator) is a dynamic simulation package that performs fast transient single and multiphase simulations of integrated subsea, topsides and onshore facilities.

ES includes a rich graphical user interface with integrated plotting to eliminate complex files and spreadsheet-based analysis.

With control emulation function and built-in capability to start from real-time process measurements, **ES** is a world-leading package for analysing integrated pipeline networks and processing facilities.

Virtuoso/OTS (Operator training system) features are coupled with the ES for realistic, comprehensive operator training.

OTS can interface directly with offline distributed control systems (DCS), supervisory control and data acquisition (SCADA) systems, or emulate operator interfaces. **OTS** is an effective tool to quickly familiarize new operators with production systems, the overall production system, prepare operators for normal and unusual operating scenarios, and document competency levels.

OTS functionalities include instructor/student workstations, user-configuration of training scenarios, automatic recording and documenting of training sessions and objective scoring of operator performance.

Real-time, online applications

Virtuoso/Monitor is an online, real-time, dynamic system for monitoring oil and gas production operations, from subsea wells to topsides equipment, in one integrated model.

Monitor's functionalities can include:

- Liquids inventory
- Management
- Line pack monitoring
- Composition and chemical tracking
- Hydrate warnings
- Leak detection
- Restriction detection module (RDM)
- Pig tracking
- Instrument and equipment surveillance
- Performance monitoring

Monitor's breadth and depth of functionalities makes it an essential tool for monitoring production and processing facilities.

"This is a personal note to congratulate your work with us on the success of the restriction detection module in our pipeline management system (PMS). Based on the PMS data, you might have noticed that we had some anxious moments here with one of our pipelines in the last week and it was detected correctly by RDM. So I am more than happy to say that it is a good system in place and I am happy about it."

Virtuoso/Advise is Wood's production management package used to provide essential decision-making support on production profiles, pigging, ramp-ups, ramp-downs, shut-downs and start-ups.

Advise continuously monitors pipeline operations and process equipment in real-time and predicts adverse conditions.

This includes the following: essential operational and commercial functionalities based on the unique challenges specific to each customer project. We address the most complex single and multiphase gathering, productions, transportation, and processing issues with our technology solutions.

This includes the following:

For gas operations:

- Suboptimal linepack
- High settle-out pressure

For gas operations:

- Holdup
- Pigging advisories
- Hydrate risks

For black-oil operations:

- Issue such as Wax
- Hydrate risks

Advise can provide advance warning of upcoming issues with operating conditions from the wells up to the receiving facilities.

Virtuoso/LDS (Leak detection system) uses robust field-proven simulation technology to quickly and accurately detect leaks in complex pipeline networks.

Our software supports single and multiphase operations, with rigorous mathematical modelling using both mass and pressure transient analysis in the pipeline. LDS also provides a comprehensive, statistical signal trend analysis with a proprietary method.

Sensitivity to leaks is maximized by a dynamic leak 'fingerprint' recognition algorithm. This reduces detection time while minimizing false alarms.

Key attributes of the software are:

For gas operations:

- Built on Wood's Virtuoso modelling technology
- Real time transient model (RTTM) with model compensated volume balance error signals and pattern recognition algorithm
- Leak detection probability with alarm notification
- Detection details include location, rate and cumulative release amount
- Operates in steady state, transient and pipeline shut-in conditions

Virtuoso/Control contains algorithms to optimize and control oil and gas production, gathering and transportation networks.

Control optimizes gas production and blending in complex gathering networks; protects wells from liquid load-up, sand-out and erosion; optimizes compressor speed and minimizes fuel usage.

Control protects vessels from flooding due to liquid slugs caused by production ramp-up and pipeline pigging. Model-determined optimum set-points are automatically and reliably transferred to the process control system to achieve target operating conditions. Using a variety of hardware and software-based redundancy with fallback strategies, Control achieves extremely high uptime and availability.

"Many of our VMS clients have been able to reduce or completely eliminate the use of physical well metering."

Virtuoso/Optimize. Wood pioneers simulation technology to deploy real-time optimization (RTO) packages in upstream production environments. Wood's unique approach to RTO makes the technology simple and totally accessible in the control room. Instead of the traditional approach of finding a steady-state optimum, **Optimize** solutions utilize the power of dynamic simulation technology to create an optimum path to the final operating point. This gives the operators a step-bystep plan and assurance that the path taken minimizes risk. The combination of feed-forward optimization with the corrective feedback mechanism makes **Optimize** the best-in-class system for any production and processing operations.

Virtuoso/VMS (Virtual metering system) is a model-based inferential multiphase metering package providing accurate and continuous calculation of individual well flow rates.

For only a small fraction of the ownership cost of physical flow meters, **VMS** reliably calculates the multiphase well flowrate and associated measurement uncertainty. This is done by utilizing various combinations of conventional wellbore and wellhead pressure, temperature instrument data and choke position.

VMS estimates the three-phase well flowrates in real time using existing instrumentation within the wellbore and on the wellhead.

The software is based on models that extend from the reservoir to downstream of the wellhead choke. Usually, there is adequate information or instrumentation available to use multiple independent models to estimate the well flow rate. This improves accuracy and makes the technique more robust and tolerant to instrumentation failures.

Typical measurements used by the system are:

- Bottom-hole pressure and temperature
- Before choke pressure and temperature
- After choke pressure and temperature
- Choke position
- Master, wing and shutdown valve status

The four building blocks that make up the **VMS** package are:

(i) a near-wellbore inflow performance model, (ii) a transient wellbore model, (iii) a choke model, and (iv) a well jumper model.

The near-wellbore model is used to provide a dynamic reservoir pressure boundary which, in conjunction with the well inflow performance relationship or productivity index, is used to estimate the flow rate across the perforations. The full-stream fluid composition, wellbore profile, tubing diameter and roughness, and the geothermal gradient are used to configure the wellbore model to predict the transient three-phase flow in the well.

Using all available pressure and temperature data, the following are solved for the flowrate in the wellbore:

- The mass-conservation equation
- The momentum-balance combined with appropriate closure laws depending on the flow regime
- Energy balance equations
- The choke model uses the choke coefficient value relationship with pressure and temperature measurements across the choke to estimate the flowrate.

Virtuoso/OTS & VP Link™ operator training systems

The primary purpose of an operator training system **(OTS)** is to provide an environment for training on control room operations of a particular asset. In the eyes of the user, the OTS serves as the practice plant, where they can familiarize themselves with the intricacies of a particular situation.

Wood's **OTS** is designed to mimic simple and very complex process systems, including those with significant potential risks which require highly trained operators to ensure plant safety and maximize productivity.

These **OTS** packages can include detailed integrated models inclusive of production wells, gathering flowlines, export pipelines and processing facilities.

In addition, the **OTS** can also be used as a tool to evaluate operating procedures, tune control loops, validate DCS configuration/logic, and carry out other engineering tasks offline without interfering with actual operations.

The level of process simulation fidelity used in these **OTS** packages depends strongly on the complexity of the actual process.

It is also influenced by the need to provide a replica of the customer's SCADA/DCS interface, either using an offline copy or an emulated system to train on.

In either case, it is further balanced by the customer's desired simulation speed. For example, on a deepwater project in the Gulf of Mexico, Wood built a customized transient engineering simulator (TES) using Virtuoso® that was later tied in with the operator training simulator (OTS). We built the high-fidelity transient physics package model which led the entire asset from the well bore to the primary separation and recirculation facilities on the topsides and supplied a custom-built user interface for running engineering simulations.

Our **VP Link** software provided the data traffic manager to push and pull data from the various control system emulations.

Virtuoso/Analytics

Analytics provides an easy to use tool for operators and engineers alike to understand real-time big data coming from their fields, allowing them to be proactive and make intelligent decisions.

Powerful modules in **Analytics** establish and help visualize meaningful patterns in streaming field information, provide insights into predictive behavior to facilitate corrective actions and improve operating performance and efficiencies of valuable assets.

Examples:

- Reservoir and well performance
- Pump efficiency
- Compressor efficiency
- Instrumentation health/status
- Corrosion/erosion issues
- Process performance

Our background and experience

Wood pioneered real-time modelling of multiphase production networks in the 1990s and has since deployed over 100 real-time simulation-based solutions worldwide.

Our passion for solving our customers' operational problems has resulted in a continuous evolution of our technology. Five core drivers are behind all the software technology that our team has created: accuracy, speed, robustness, scalability and flexibility.

We deliver fit-for-purpose solutions for each facility in order to address the challenges our clients face. Our wide-ranging knowledge enables us to design solutions that are easily integrated into everyday operations and deliver sustained value.

Today, Virtuoso is used to help manage some of the world's key gas resources, supporting 10% of global gas consumption.

"All, just wanted to offer my congratulations on the first successful trunkline pig run at full rates. From a project flow assurance perspective this latest pig run is a major milestone as it has verified the steady state liquid hold-up in the trunkline and Virtuoso confirmed that we can pig the system at full rates when required within slugcatcher capacity. Pigging a three phase pipeline is technically challenging. To have pigged the pipeline with no slowdown or interruption to LNG production and with slugcatcher interface levels managed so efficiently is a first for us and a great result. Great work."

Wood. Powered by possible

The need for change has never been greater. In our industries, in the way we treat our planet, and in how we live.

To challenge the status quo we must be brave – it's having the courage to forge new answers. We're 40,000 inquisitive minds, on a quest to unlock solutions to the world's most critical challenges, across all of energy and the built environment.

United by our mission to create a sustainable future as the world evolves to a cleaner planet. Our bold spirit drives us to lead the charge, our actions transform challenges into solutions, and our curiosity keeps us pushing, innovating, making the impossible... possible.

Because we understand the time for talk is over. Because the world needs new answers to old challenges. Because at Wood, we are future ready, now.

For further information please go to:

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