

wood.

Virtuoso®

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





Asset Performance Management & Optimization

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

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.

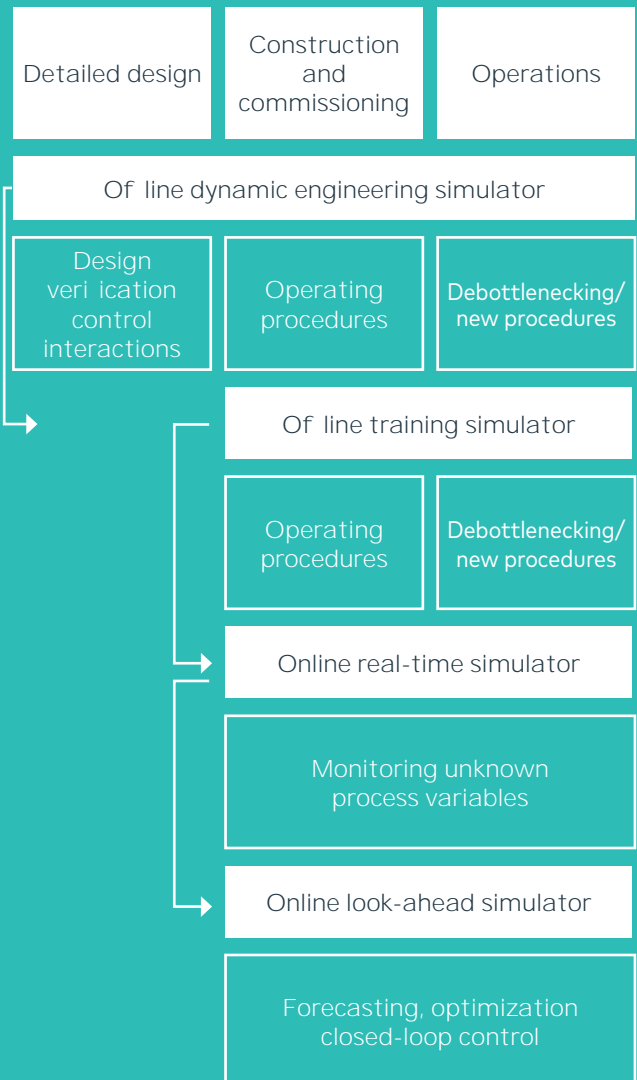
The **Virtuoso** software suite includes of line packages such as:

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

The online packages include:

- **Virtuoso/Monitor** - Operations monitoring
- **Virtuoso/Advice** - Operations advisory
- **Virtuoso/LDS** - Leak detection system
- **Virtuoso/Control** - Operations control
- **Virtuoso/Optimize** - Operations optimization and planning

Stages of application



Of line applications

Virtuoso/ES (Engineering simulator) is a dynamic simulation package that performs fast transient simulations of single phase and multiphase conditions, including specialized operations that have rich CO₂ streams for CCS (Carbon Capture and Storage applications) and H₂ (rich-stream and mixed stream transport and blending).

Virtuoso/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 analyzing 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 of line 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.

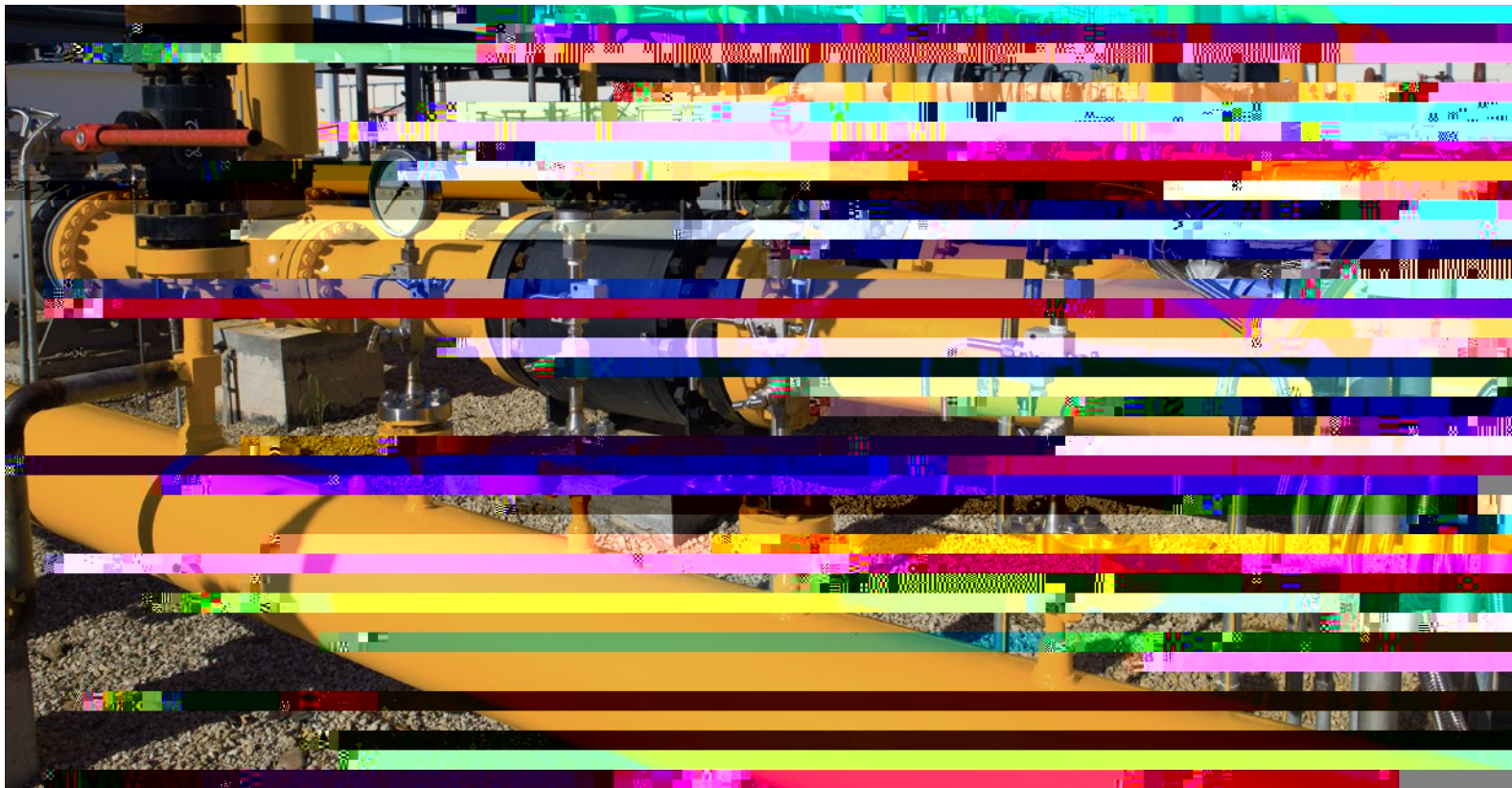
OTS functionalities include instructor/student workstations, user-configuration of training scenarios, automatic recording and documenting of training sessions and objective scoring of operator performance.

Real-time, online applications

Virtuoso/Monitor and Virtuoso/Advice is an online, real-time, dynamic system for monitoring oil and gas production operations, from wells to processing equipment, to export, transmission and distribution systems.

Virtuoso's functionalities can include:

- Leak detection and location
- Line pack monitoring
- Composition tracking
- Compressor monitoring and optimization
- Batch tracking
- Pump monitoring and optimization
- Surge monitoring
- Pig/scrapper tracking
- Flow restriction or blockage detection
- Instrument and equipment surveillance and condition monitoring



Uses/Applications

- Online Monitoring
- Standard Look-Ahead Prediction
- What-If Look-Ahead Prediction
- Gas Pipelines, including and H2
- Pipeline Surveillance Monitoring
- Line Pack Monitoring & Optimization
- Surge Time
- Compressor Monitoring & Optimization
- Gas Composition Tracking & Blending
- Leak Detection & Location
- Destination Tracking and Blending
- Emissions Monitoring
- Pig Tracking
- Liquid Products Pipelines
- Water Pipelines
- Chemical Injection Lines, including MEG
- Liquid Surge
- Pressure Surge
- Pump Monitoring & Optimization
- Batch Tracking
- Virtual Gauges (P, T, etc.)
- Operations Planning
- Offline Simulation
- Operator Training
- Operating Envelope Advisor
- Restriction Detection
- Instrument Fault Detection
- Data Replication/Visualization
- Safety Valve Testing
- Mechanical Limits Monitoring
- Procedure Validation
- Flare Monitoring



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 phase and multiphase operations, with rigorous mathematical modelling using both mass and pressure transient analysis in the pipeline. **Virtuoso/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:

- 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, export and transmission networks.

Virtuoso/Control optimizes various facets of operations, from protecting wells from liquid load-up, sand-out and erosion; optimizing compressors and pumps, to minimizing fuel usage and overall uptime and profitability.

Virtuoso/Control protects processing equipment from upsets. 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, **Virtuoso/Control** achieves extremely high uptime and availability.

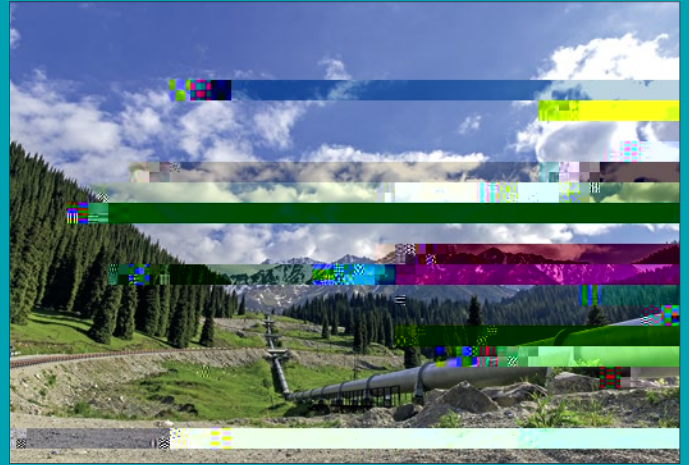
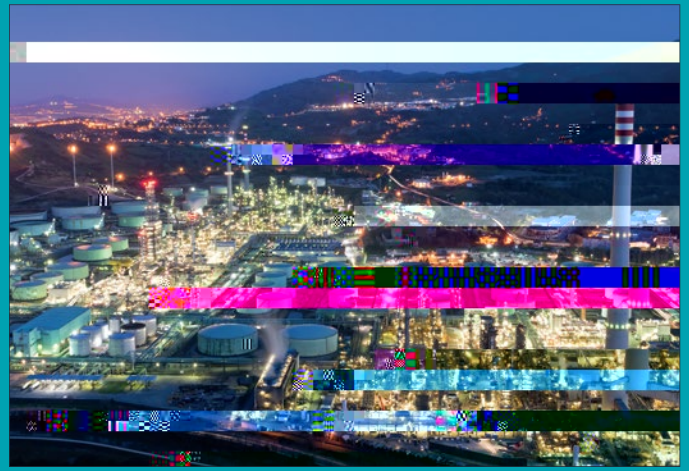
Virtuoso/Optimize. Wood pioneers simulation technology to deploy real-time optimization (RTO) packages in upstream production environments. Wood's unique approach to RTO makes

the technology simple and totally accessible in the control room. Instead of the traditional approach of finding a steady-state optimum, **Virtuoso/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-by-step 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/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:

- Compressor efficiency
- Pump efficiency
- Pipeline performance
- Instrumentation health/status
- Corrosion/erosion issues
- Process performance

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. 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 of line 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 off-line copy or an emulated system to train on. In either case, it is further balanced by the customer's desired simulation speed.

For production operations, Virtuoso/VMS provide accurate estimates of the 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.

The four building blocks that make up the Virtuoso/VMS package are: (i) a near-wellbore in low 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 in low 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 well flowrate:

- mass-conservation and energy balance equation
- momentum-balance combined w/ closure laws depending on the flow regime
- choke model uses choke coefficient value relationship w/ P and T measurements across the choke to estimate the flowrate.

Wood is a global leader in the delivery of project, engineering and technical services to energy and industrial markets. We operate in more than 60 countries, employing around 55,000 people, with revenues of around \$10 billion. We provide performance-driven solutions throughout the asset life-cycle, from concept to decommissioning across a broad range of industrial markets including the upstream, midstream and downstream oil & gas, chemicals, environment and infrastructure, power & process, clean energy, mining and general industrial sectors. We strive to be the best technical services company to work with, work for and invest in.