# Open Inventor for Oil & Gas, Mining, and Geosciences

High-performance 3D Software Development Tools

Open Inventor® is an object-oriented 3D software development toolkit (SDK) for the development of professional interactive applications using C++, .NET or Java, on cloud, desktop, and mobile environments. Its easy-to-use API, extensible architecture, and large set of advanced built-in components provide developers with a high-level platform for integrating, in a simple and consistent way, powerful 3D visualization and analysis capabilities into software applications for seismic interpretation, geo/environmental modeling, reservoir engineering, well planning, mine planning and design, and all Exploration & Production fields.
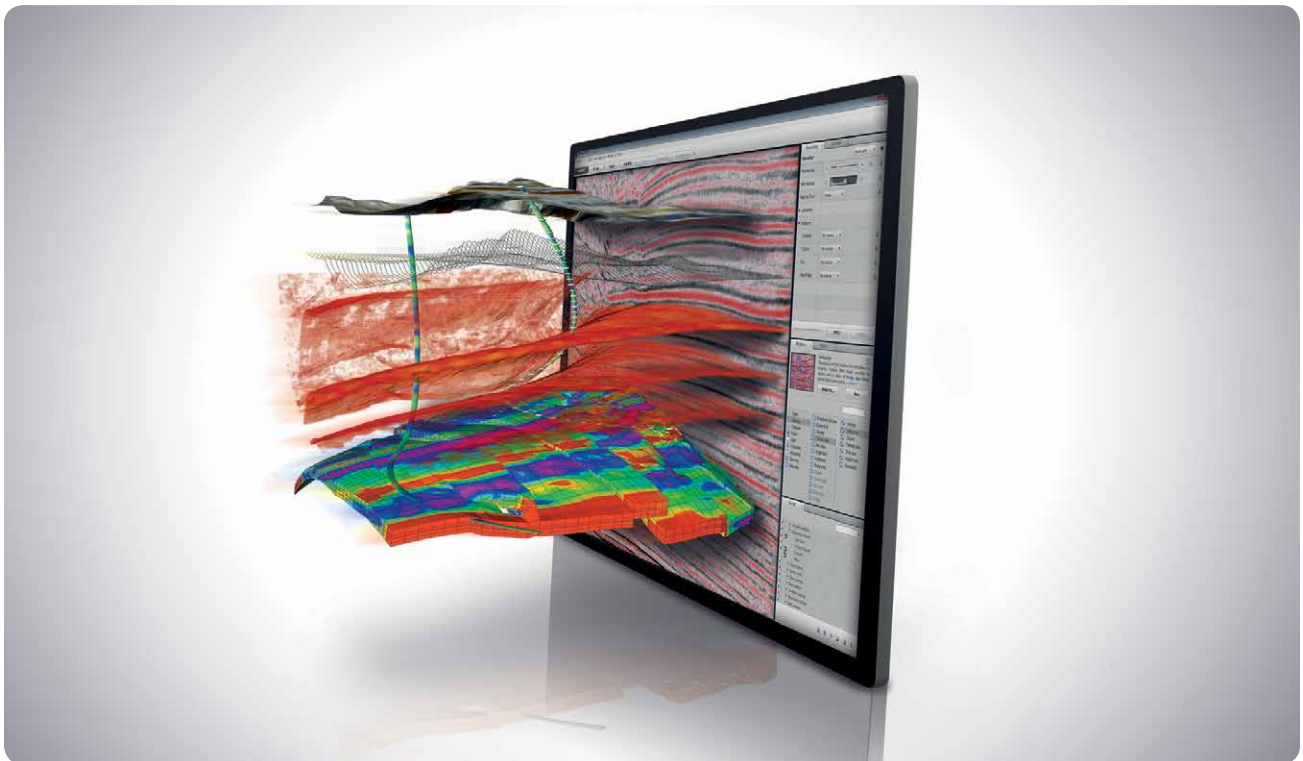
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Power your software development with Open Inventor

Integrate 3D in your software for:

- Seismic interpretation
- Geological modeling
- Seismic processing
- Sensor data analysis
- Well planning
- Reservoir modeling & simulation
- Borehole logging & imaging
- Geosteering, well drilling
- Microseismic monitoring
- Core analysis & petrography
- Mine planning & design
- Ventilation modeling
- Environmental studies
- GIS
- Real-time simulation & training

Open Inventor is used by:

- Foster Findlay Associates Ltd (ffA)
- Geomodeling Technology Corp.
- Geovariances
- GX Technology (GXT)
- IFP Energies Nouvelles
- Petrosys Pty Ltd
- Roxar Software Solutions
- Runge Ltd
- Schlumberger
- Seismic Micro-Technology, Inc. (SMT)
- SeisWare International Inc.
- Weatherford

Go to market faster

- Rapid prototyping and development
- Object-oriented API and components
- Multi-platforms and multi-languages support
- Advanced debugging and productivity tools
- Easy deployment and easy integration with existing applications

Deliver state-of-the-art 3D

- State-of-the-art 3D engine
- Powerful scene graph architecture
- Cutting-edge volume rendering
- High image quality
- Advanced support of meshes and grids
- Automatically optimized rendering

Solve the toughest 3D challenges

- Very large data management
- Fusion of multiple data types
- Scalable to multi-displays/GPUs/CPUs
- Cloud/mobile remote visualization

Reduce maintenance costs

- Clear and thorough documentation
- Prompt, effective support hotline
- New features and techniques added constantly

Much more than a 3D toolkit

- Unparalleled professional support and consulting
- Customization, cooperative R&D
- Active users community
- Rich and flexible licensing model
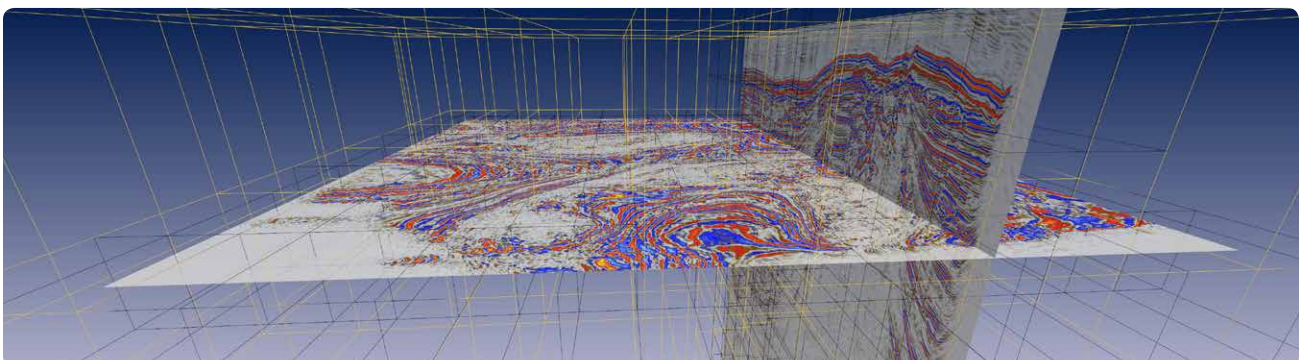
↑ Courtesy of CGG.

About Open Inventor

Open Inventor is a 3D software development toolkit (SDK). It is a set of high-level 3D image visualization, processing and analysis libraries integrated as third- party components of an application, and accessible through an object-oriented API.

Open Inventor provides the power and functionality of OpenGL® at an object-oriented level, including a scene graph architecture to manage data, a highly optimized 3D rendering engine, an extensive set of built-in components and numerous classes to manipulate data using high-level concepts. In addition, Open Inventor's specialized extensions provide sets of dedicated features for specific needs and applications.

Open Inventor

Open Inventor provides an object-oriented API which gives access to high-level classes and methods dedicated to 2D/3D image data visualization, processing, analysis and management. Open Inventor implements a scene graph paradigm for ready-to- use graphics programming patterns. It also provides a large set of built-in components which deliver simple and efficient ways for developing any kind of 3D data visualization and management features.

VolumeViz

The VolumeViz extension implements high-quality ray-casting volume rendering, built-in modules for manipulating 3D-image data and a unique Large Data Management technology for out-of-core data support, up to terabytes of data.

VolumeViz delivers state-of-the-art image quality with the latest algorithms implemented on the GPU. It provides developers with high-level classes that efficiently implement volume data visualization. VolumeViz Large Data Management (LDM) technology enables access to out-of-core data with optimized multi-resolution management to perform synchronous or batch computations on very large volume data.

MeshViz

The MeshViz extension delivers advanced support for any type of 2D or 3D mesh. It provides a rich set of effective representations such as isosurfaces, skins, cross-sections, skeletons, streamlines, isolines. It also provides advanced mesh extraction tools allowing extraction of new meshes representing specific features. Built upon a unique technology, MeshViz provides a virtual data access interface, which allows support of any kind of mesh and unique memory optimization for data storage making it possible to handle several-hundred-million cell models. Finally, MeshViz offers a collection of high-level objects for implementing a wide range of charting types.

ImageViz

The ImageViz extension allows easy integration of advanced 2D and 3D image processing and analysis capabilities into imaging software applications. It provides an extensive collection of high-performance parallelized 2D/3D image processing and analysis operators to implement complete application workflows, including image filtering and pre-processing, segmentation, and data analysis. ImageViz allows developers to build automated workflows.

RemoteViz

The RemoteViz extension enables easy integration of a virtual Open Inventor viewer in web pages, allowing the development of web-based applications with client-server architecture. RemoteViz takes care of transporting mouse, keyboard, and multi-touch interactions from Client to Server, and 3D rendering visualization from Server to web-based Client.

HardCopy

The HardCopy extension allows applications to output 3D graphics in PDF3D®, as well as other vector formats including, CGM, HPGL, PostScript® and GDI EMF (Microsoft® Windows®). Unlike pixel-based image output formats, these vector formats provide high-quality, resolution-independent output suitable for large format plotters.
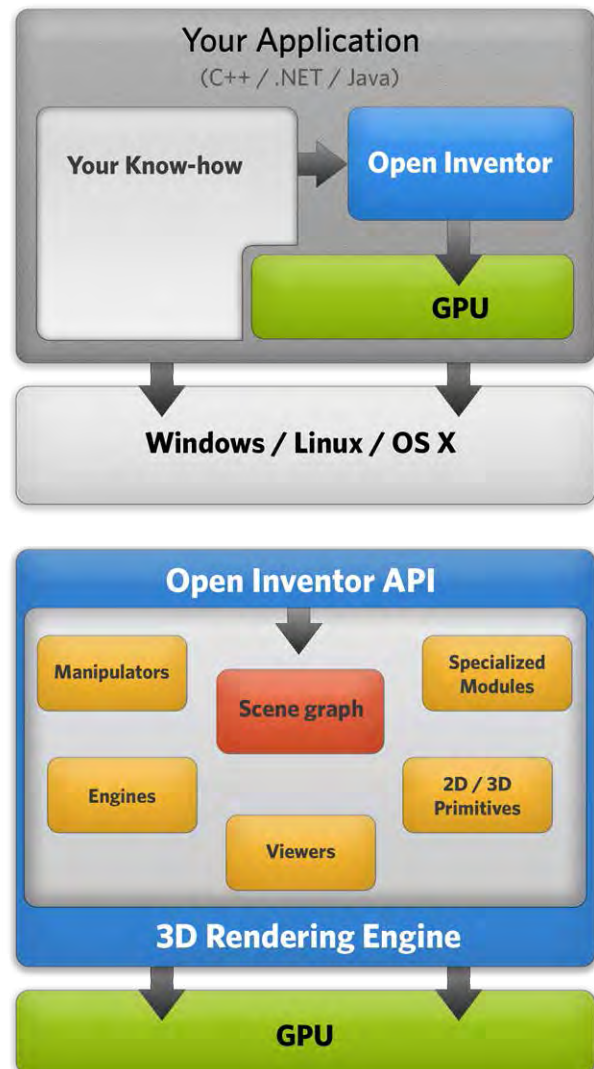
Integrate high-performance 3D visualization into your software applications

Developers of both commercial and internal use software applications leverage the Open Inventor toolkit for integrating advanced 3D visualization into their applications. Here are some highlights of how the Open Inventor technology can be used to create high-performance software in the energy sector.

Sensor data analysis

Land surveying, Seismic surveying, Marine survey, Pipeline integrity check,· Real-time monitoring of mine wall movement or mine shaft stability, Underground mine volumetric survey.

Surveyors obtain extra information from raw 2D and 3D survey data which can be lost as data get processed. Interpreters therefore increasingly want to analyze the raw data using software that can provide them with interactive and real-time visual feedback. Real-time visualization allows them to focus on executing the job at hand/ on-site, and delivering the final results faster.

Open Inventor enables specialized survey software to integrate efficient and interactive 2D/3D visualization of very large seismic data sets. Open Inventor VolumeViz Large Data Management (LDM) enables out-of-core data visualization and computation on extremely large data sets, using on-demand multi-resolution data pre-fetching. LDM data loading can be driven by camera-based heuristic or by application specific needs, such as slice scanning or connectivity hunting.

Moreover, Open Inventor allows for optimal display for point cloud data collected with 3D laser scanners.
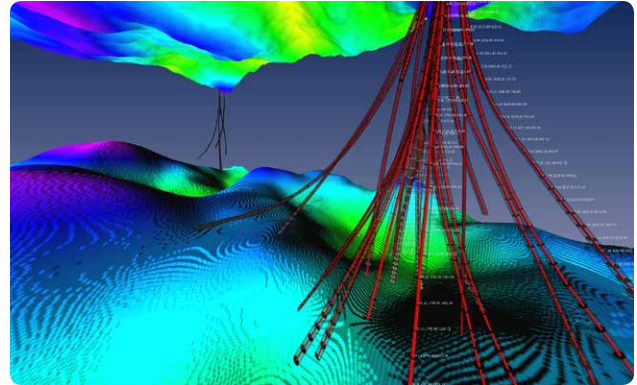
Seismic processing & interpretation

The Open Inventor VolumeViz Large Data Management (LDM) technology is a revolutionary 3D visualization solution to expand the frontiers of understanding for massive seismic data volumes (greater than several hundred GBs). Unprecedented rendering quality is available through the use of programmable shaders and direct GPU-based rendering. Multi-data support, such as data combining and transforming, can be used to assist in understanding the true meaning of data.

The Open Inventor API is a unique middleware with integrated access to the visualization and computation capabilities of the GPU. It provides application developers with infinite possibilities for massive dynamic or static computation capabilities on seismic data with simultaneous 3D visualization feedback, leveraging the latest graphic board solutions to perform intensive parallel computation on the workstation.

The full integration of LDM, GPU computing, and seismic visualization makes Open Inventor one of the most advanced technologies for real-time seismic processing and interpretation.

Borehole logging & imaging, geosteering, well drilling

Comparing well logs to the processed seismic data can be challenging. The Open Inventor toolkit provides the tools to integrate data from a wide range of scales and resolutions, making it easier to validate the seismic or dip integrity and give a broader understanding of the geology. Open Inventor provides advanced Level of Detail (LOD) support for visualizing very large data sets that exceed memory.

Monitor in real-time (with 2D and 3D canvases), LWD rock and fluid properties of the formation. Combine and compare simulated properties with acquired measurements. Enable real-time geosteering workflows with fully integrated 3D visualization powered by Open Inventor.

Well planning

Open Inventor helps to integrate interactive 3D visualization into well planning solutions, enabling real-time and collaborative monitoring to support conventional and unconventional Oil & Gas projects.

Here is just a selection of features that you can achieve using Open Inventor: display of the entire exploration field in 3D, including surface features (such as mountains, lakes, building and GIS information), interpretation features (such as faults and horizons), reservoir simulation post-processing, the planned well path and drill pads; co-visualization of offset wells and logs; interactive manipulation of 3D well targets; spline interpolation with collision detection; dynamic updates of application-driven results (such as drill cost, production rate, fracture orientation, horizontal spacing); and more.

Enabling collaborative workflows, Open Inventor applications can be ported with minimal effort from a desktop to large screen stereo displays and fully immersive environments, and provides support for floating 3D user interfaces.

Microseismic monitoring

From open-pit/underground mine monitoring to mapping of hydraulic fracture stimulation or seismic moment tensor (SMT) analysis on microseismic data, 3D visualization is the key to fully exploit your data. Use Open Inventor cutting-edge technology to create advanced visualization features in specialized microseismic monitoring software applications. Build extremely large numerical models, interactively cross-plot microseismic attributes, correlate microseismic data to seismic attribute data, calibrate horizontal well data to seismic attributes to quantify fracture density variations, and more.

" We chose Open Inventor because of its unrivalled 3D graphics capabilities, easy integration into Petrosys software's development process, and support of Windows and Linux desktop environments "

The Petrosys Development Team
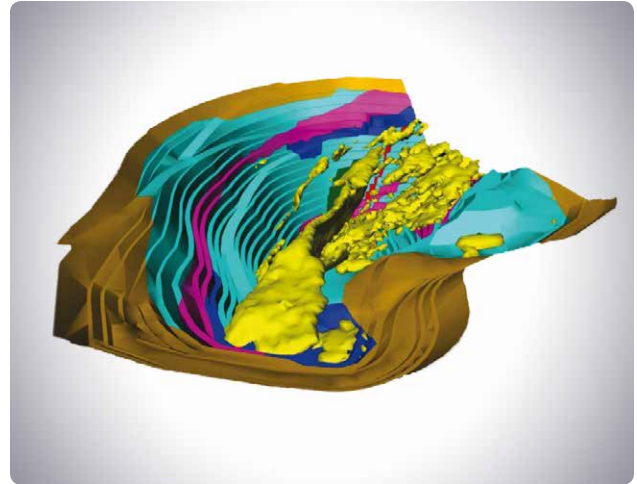
Reservoir modeling & simulation

Open Inventor provides powerful and comprehensive solutions to applications developers who require rapid integration of a 3D visualization engine for advanced reservoir engineering.

Accurately represent multi-property reservoir models with a wide range of grid types: pillar and PEBI grids, structured and unstructured grids, local grid refinement, and virtually any kind of grid data thanks to a Virtual Data Access API.
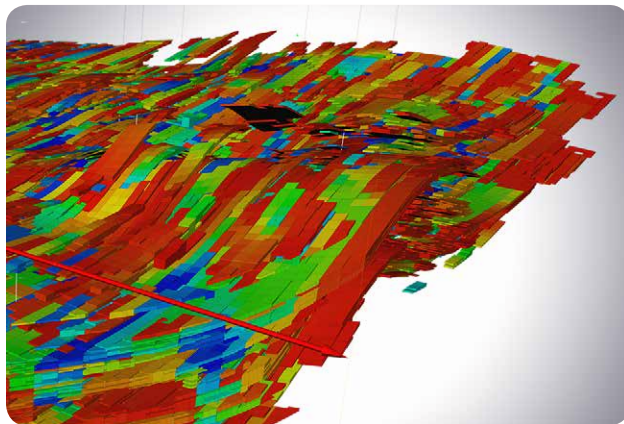
Use the MeshViz comprehensive library of high- level 3D grid data mapping and extraction (isosurfaces, grid skin, arbitrary slice, flow path streamlines, cell filtering, and more.), and ready-to-use 2D plot components.

MeshViz's unique Virtual Data Access technology allows post-processing of several-hundred-million cell grids.

Expand your data support capabilities to simultaneously handle seismic and reservoir data by combining MeshViz with VolumeViz.

↑ Courtesy of Runge Ltd.

Manage very large block models using Open Inventor VolumeViz Large Data Management technology thanks to a highly optimized data structure and built-in out-of-core data support.

Map multiple properties onto grid models to better understand the geometry that controls your ore body. Fuse together multiple volumetric and/or surface data in the same scene graph for advanced geotechnical analysis.

Scale performance of mine models using ScaleViz technology which implements distributed rendering on multi-GPU and clusters, and visualize very large data sets at interactive frame rates.

↑ **Post-processing of reservoir simulation.** Courtesy of Amarile.

Mining
Mine planning, Geological interpretation & modeling, Ore body modeling, Open pit & underground design, Haul road design, Ventilation modeling.

Open Inventor's sophisticated built-in components enable mining software producers to easily integrate cutting-edge visualization capabilities in their applications.

Use the Open Inventor advanced viewer, fast editing modes, and high-performance primitives to produce complex mine designs and production scenarios.

Take advantage of the Open Inventor advanced mesh API (MeshViz) for mine mapping, modeling and analysis, which include: powerful memory management allowing the interactive rendering of several-hundred-million cell grids, on-the-fly geometry or property generation, complete mapping functionality, companion classes for charting and axes, and support of any type of mesh.

Environmental studies
Groundwater analysis, Marine oil spill modeling, Pollutant emission analysis.

Effective management tools for groundwater and environmental data require advanced modeling, simulation and visualization capabilities.

From raw data to the conceptual model to numerical simulation data post-processing, Open Inventor provides software developers with the components to build groundwater models including support for multiple data import, superimposition of geospatial data, 3D grid/mesh generation for numerical simulation, simulation results visualization, and much more.

Moreover, Open Inventor provides an open platform that allows custom data visualization and processing module integration, within a consistent and unified workflow.

Real-time simulation & training

Mining equipment training simulator, Security management simulation, Simulators for Oil & Gas, mining and nuclear.

Human simulation in a virtual environment helps promote safer operations by evaluating new equipment and providing advanced training to operators.

Open Inventor provides simulation applications with leading-edge technology to visualize extremely large data in laptop, desktop, or immersive and collaborative environments. Open Inventor applications can be ported with minimal effort from a desktop to large screen stereo displays and fully immersive environments, and provides support for floating 3D user interfaces.
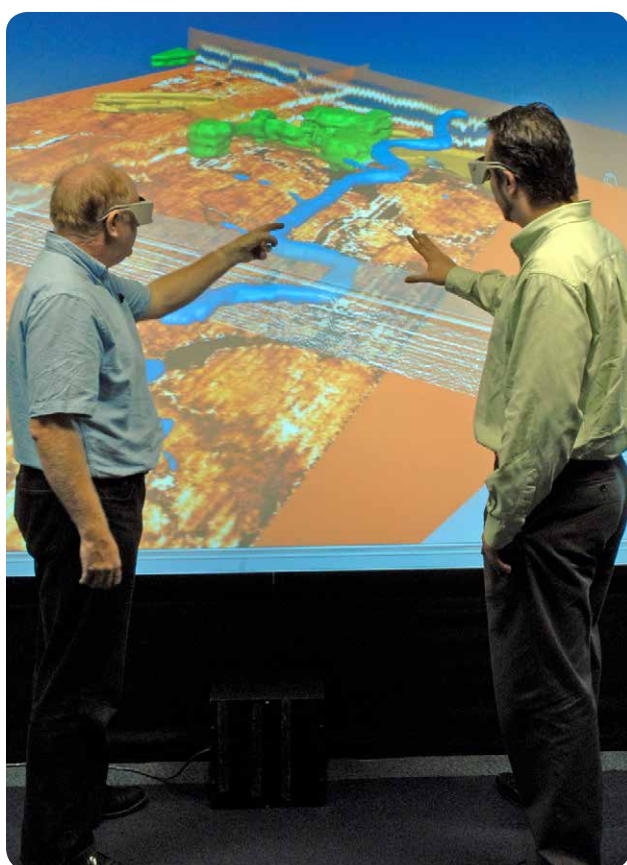
↑ **University of Birmingham.** Data courtesy of PGS.
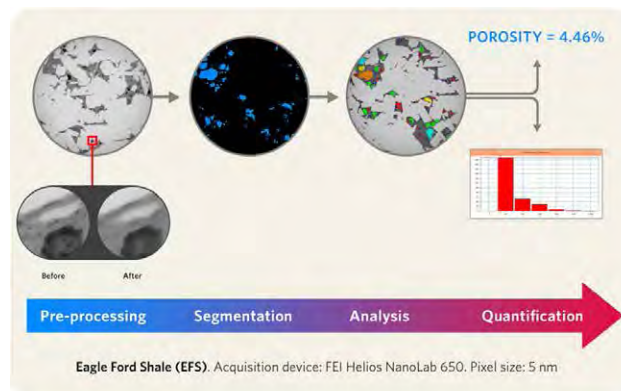
GIS

Open Inventor provides advanced support for large 2D imagery, 2D/3D surfaces and geometries, data mapping, with a rich set of effective graphics representations, as well as a comprehensive library of functions for charting, legends, markers and numerous statistical representations.

Open Inventor library includes support for coordinate system projections transformation on geometries and volume rendering. GeoVRML standard is supported as well.

Core analysis & petrography

Open Inventor allows developers to efficiently create advanced 3D visualization and analysis tools for exploring large core sample data sets.

Open Inventor supports visualization of all data types involved in modern digital rock analysis, such as out-of- core 3D volume rendering, image processing and segmentation, 3D meshes, pore networks and post-processing for multi-phase rock fluid simulation.

POROSITY = 4.46%

Before   After

| Pre-processing | Segmentation | Analysis | Quantification |

Eagle Ford Shale (EFS). Acquisition device: FEI Helios NanoLab 650. Pixel size: 5 nm

" *Leveraging the GPU for computation via Open Inventor's shader-based capabilities has allowed us to create a very powerful, highly interactive workflow for seismic facies analysis. The level of interaction achieved approaches real time* „

By Stephen Purves, Director of Technology at ffA

Why Use Open Inventor

Visualization isn't just drawing pictures of your data. Visualization is about managing, transforming, presenting and visually interacting with your data to extract information, gain knowledge and achieve business goals. So the Open Inventor 3D visualization toolkit does much more than drawing pictures. Open Inventor provides the

advanced tools for data management, computing, rendering and interaction used throughout the energy industry.

Software vendors, corporate developers, research groups and innovative startups all utilize Open Inventor to integrate high-quality and high-performance 3D visualization and image processing into their software applications. Partnering with the visualization experts at FEI Visualization Sciences Group means that your in-house developers can focus more on their domain specific expertise and bring effective software solutions to market faster.

3D hardware is ready
The performance and features of modern 3D hardware allow both high image quality and interactive rendering, even for large data sets.

At the low end, even relatively inexpensive video game 3D boards have the capability to do high quality rendering at interactive speeds for smaller data sets. At the high end, large on-board memories and the ability to combine multiple high-end 3D boards have dramatically increased the amount of data that can be directly loaded on the device.

Unlike the CPU, the speed and capacity of 3D boards is still increasing at a very fast pace. This means that 3D rendering is now a practical option for any program, whether it's a new development or an upgrade, and Open Inventor makes it easy to add this extra dimension.
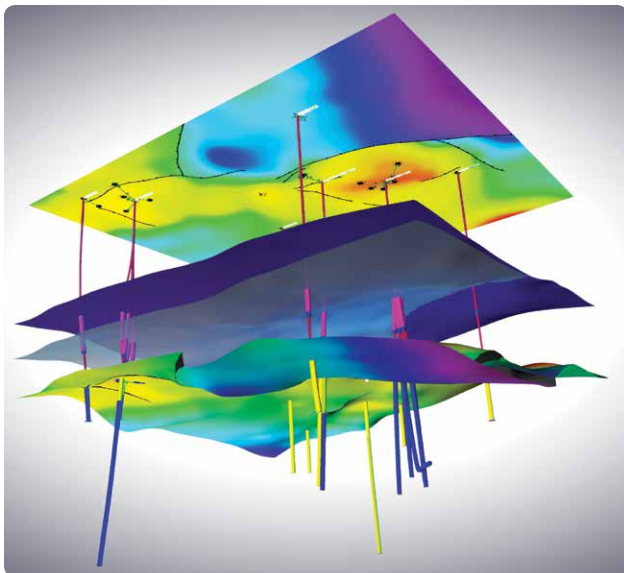
Go to market faster
Developers working directly with OpenGL commonly have to re-invent the wheel, starting with setting up a window for 3D rendering and continuing with providing tools for the user to navigate through the 3D scene and to interact with the 3D scene. Open Inventor handles all the details of window/hardware setup, usually by just adding a 3D widget to your user interface, whether it's part of the main window or in a dialog box. Open Inventor can also render into any initialized OpenGL window, making it easy to integrate with and enhance existing applications.

Open Inventor provides powerful viewer classes for 3D navigation that have been tested and improved over many years to provide a good experience for your end users. The viewer classes have built-in support for stereo rendering, full screen rendering, anti-aliasing and much more.

Open Inventor also provides powerful tools for interacting with the 3D scene that make it easy to provide features such as direct dragging of slices and selection of voxels. All these high level functions and prebuilt "wheels" allow you to spend more time using your expertise to add value to your application.

Another essential productivity tool is the IVTune utility, packaged with Open Inventor. IVTune provides developers with an interactive symbolic view of the scene graph to trace debug and tune their application at run time.

↑ Courtesy of Petrosys.

" *Open Inventor provides unique advantages for the development of the Isatis software such as the availability of high-performance tools to deal with the ever increasing size of data volumes, its cross-platform compatibility, the C++ API, and the top quality support team and training program* „

J.P. Roux, Sales & Marketing Director at Geovariances
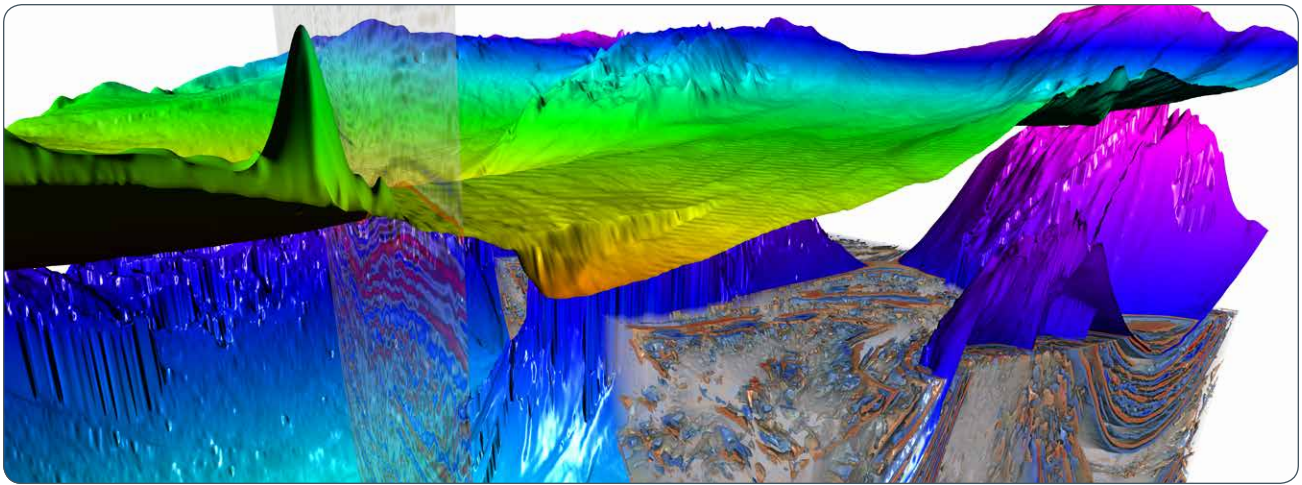
↑ Courtesy of CGG.

High-performance 3D

Open Inventor provides software engineers with a robust 3D foundation that efficiently addresses challenging issues such as managing data exceeding CPU/GPU memory, displaying and manipulating different types of data at the same time, scaling performance across multi-CPU/GPU configurations, or support integrated computation.

The VolumeViz extension enables access to out-of-core data with optimized multi-resolution management. VolumeViz also provides a rich data access API that allows applications to take advantage of the LDM technology for accessing data associated with a sub-volume, plane, point or poly-line at arbitrary resolution. This makes VolumeViz not just a visualization toolkit but also a powerful middleware for volume data management.

Open Inventor supports all kinds of 2D/3D data: image data, volumes, complex meshes and geometries, charting, graphs, text, etc. which can be managed in the same scene graph, displayed and manipulated at the same time. Open Inventor provides full interoperability between display and computing. CPU, CUDA™ and OpenGL devices can be equally used to work with geometry or any data, delivering a unique development framework to integrate synchronous high-performance computation tasks within an interactive 3D graphics application.

State-of-the-art volume visualization

The Open Inventor VolumeViz extension provides the latest in state-of-the-art rendering and image enhancement techniques for all types of 2D and 3D image data. Taking full advantage of the flexibility of OpenGL shaders and of the power of GPU parallel processing architecture, VolumeViz delivers both optimal performance and fully configurable rendering capabilities.

Both interactivity and image quality are important, but it may not be possible to maximize both at the same time. Even a high end graphics board may slow down when performing very high quality rendering in a large window. So VolumeViz provides the options you need to maximize interactivity or image quality or take a balanced approach. It can even adjust the balance automatically and temporarily decrease the image quality during interaction, then return to full quality when the interaction stops.

Furthermore, VolumeViz provides a number of techniques to improve image quality without decreasing performance, as well as image enhancement techniques.

In addition to the many built-in shader programs, Open Inventor allows the application to provide its own shader programs to implement specific algorithms.

" *To develop the 3D Seismic Visualizer application for our clients, we selected Open Inventor because it is a cost-effective, robust, easy-to-implement, solution, and something SeisWare software could continually integrate with, as new functionality and enhancements are added to the interpretation package„*

The SeisWare Product Management Team

Mega-million cell data support.

The MeshViz extension has been designed to provide advanced support for mesh and grid data.

It provides powerful tools for extracting features such as contour lines and isosurfaces, and for mapping scalar, vector and tensor data fields onto 2D and 3D meshes.

Using a unique direct data access architecture, MeshViz can handle very large meshes (hundreds of millions of cells) without duplicating application data. It can handle any type of mesh, whether it's regular, unstructured, polyhedral or quadratic. The data access architecture allows the application to maintain its data in any desired type (int, float, double, etc.) and any desired organization.

For example, a VolumeViz data set can be used directly as input to MeshViz without copying or converting the data. This allows, for example, the extraction of isosurfaces geometry directly from volume data. Extracted isosurfaces are 2D meshes from which isolines can be extracted, allowing surfaces to be colored or contoured according to a scalar data field.

Advanced image processing and analysis

Open Inventor ImageViz SDK provides an extensive collection of high-performance parallelized 2D/3D image processing and analysis operators to implement application workflows, including:

· Pre-processing: 2D/3D image cleaning and enhancement

· Segmentation: identification of objects, phases, defects, and regions of interest

· Analysis: data quantification and numerical results

Process a wide range of image data, including 2D and 3D, grayscale and color, various bit-depth images, very large images, data from X-ray tomography, electron and optical microscopy, MRI, or any other image acquisition systems.

Implement automated image processing and analysis workflows and provide software users with faster, more accurate and more complete insight into their data.

Interactive remote visualization

Remote visualization allows your end- user to be at one machine, while the application and/or the 3D rendering run on a visualization server located anywhere on the network. A user needing to access and visualize large datasets can take advantage of remote visualization to avoid moving the data to the local machine and/or overcome graphics limitations of the local machine.

You can add an Open Inventor service to your web-based application - on the server side -, and benefit from rich and interactive remote 3D visualization capabilities for your mobile applications.
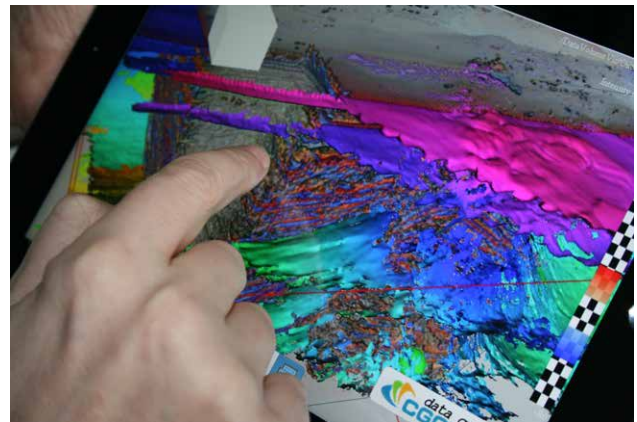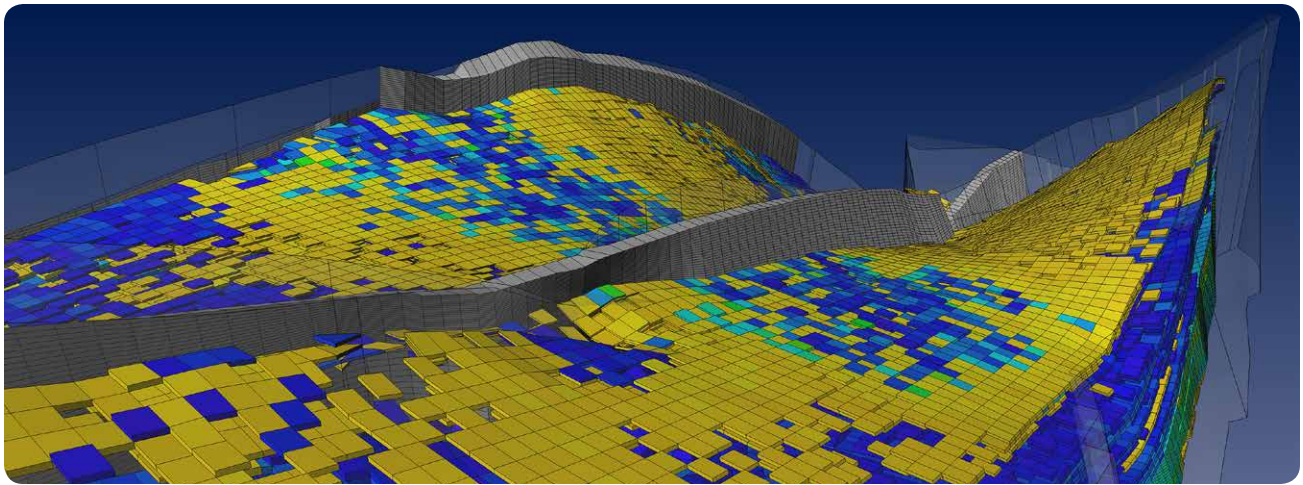

↑ Courtesy of CGG

Avoid low-level APIs

Using the scene graph paradigm provided by Open Inventor is fundamentally more productive as a result of being object-oriented, using good design patterns, automatically using all available features, automatically optimizing rendering and by implementing commonly used higher level components.

Open Inventor is also easily extended and, unlike toolkits that hide the abstract hardware interface, Open Inventor still allows you to call the lower level API directly if you need to. Because Open Inventor uses OpenGL for rendering, you can be sure that rendering code is highly tuned for this interface, but also that any extension code you write will be portable to any platform, just like Open Inventor itself.

↑ Courtesy of CGG.

Flexible deployment, future-proof development

Open Inventor is an open framework designed to facilitate code integration in both directions: integrating the Open Inventor API into your existing application(s) and integrating your existing (or future) visualization code into Open Inventor.

Open Inventor supports development in C++, C# (.NET) or Java using a fully native API layer, Open Inventor viewer objects can be easily added to your user interface using any native "widget" as a placeholder.

Applications can integrate their existing or future custom visualization code into Open Inventor in a seamless way by creating custom nodes that extend the set of scene graph objects and by creating custom GLSL shader functions. Open Inventor provides documentation and an API to minimize the effort to create custom nodes and custom shaders.

Strong support

Open Inventor is developed and maintained by a highly qualified professional team and is evolving on a regular basis, enhancing the product to integrate the latest techniques, addressing customers' specific requests and providing timely fixes for potential issues.

For 25 years, FEI Visualization Sciences Group has been providing its customers with powerful, efficient solutions for all their 3D visualization requirements, targeting time sensitive delivery of applications that need to deal with huge data sets, in fact applications that need all of this without sacrificing performance.

The Open Inventor SDK is much more than just a library of functions and a reference manual. Many tools are available to help you get started quickly and get your job done faster: advanced user's guide, fast start screencasts, training, consulting, and a skilled and reactive technical support service. Open Inventor is professionally supported by a dedicated, experienced customer support team, highly praised by our customers.

Wide adoption

Supporting major applications in the energy sector for over 18 years, Open Inventor has proved to be an efficient and cost-effective solution. In fact, Open Inventor is the most widely used scene graph API across many application areas ranging from seismic interpretation to industrial engineering to fields of science. Our customers have shipped hundreds of thousands of copies of applications based on Open Inventor and thousands of developers are actively using Open Inventor.

In addition to the direct benefits of using Open Inventor, belonging to an extensive community of users brings many indirect benefits. Open Inventor users can take advantage of direct interaction with other users through our forum:

www.openinventor.net

Power your software development with Open Inventor®

Deliver state-of-the-art 3D

Open Inventor provides the power and functionality of OpenGL at an object-oriented level. The easy-to-use API, extensible architecture, and large set of advanced components provide software developers with a high-level platform for rapid prototyping and development of advanced 3D graphics applications.

Open Inventor extensions add specialized capabilities for the interactive visualization of very large (out-of-core) volume data, advanced image processing and analysis, efficient support for very large cell 3D models, interactive remote visualization, and 3D graphics output.

Build robust foundations

Open Inventor is proven to be the safe choice for the long term and the most flexible tool to transfer technology evolutions and unique innovations to your solutions.

Extensions of the API and new class modules are carefully designed to introduce powerful new capabilities for your application in the most simple, transparent and consistent way, protecting your investment and anticipating needs that you may not even foresee. Last, the interoperability and extensibility ensure your complete freedom to best adapt the toolkit to your specific needs.

Rely on strong support and innovation

Dedicated to serving our customers, FEI Visualization Sciences Group brings more than 25 years' experience in 3D visualization. Our support team pays particular attention to constraints of professional developers, working closely with R&D for best phasing with your development schedule.

Our Professional Services team is available to increase your efficiency through training, consultancy and custom development covering the whole life cycle of your project: from software and hardware requirements, prototyping, migration assistance, tosystem deployment and even cooperative R&D.

Open Inventor is available for Windows®, OS X®, Linux.
Languages: C++, .NET, Java™.

FEI™

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