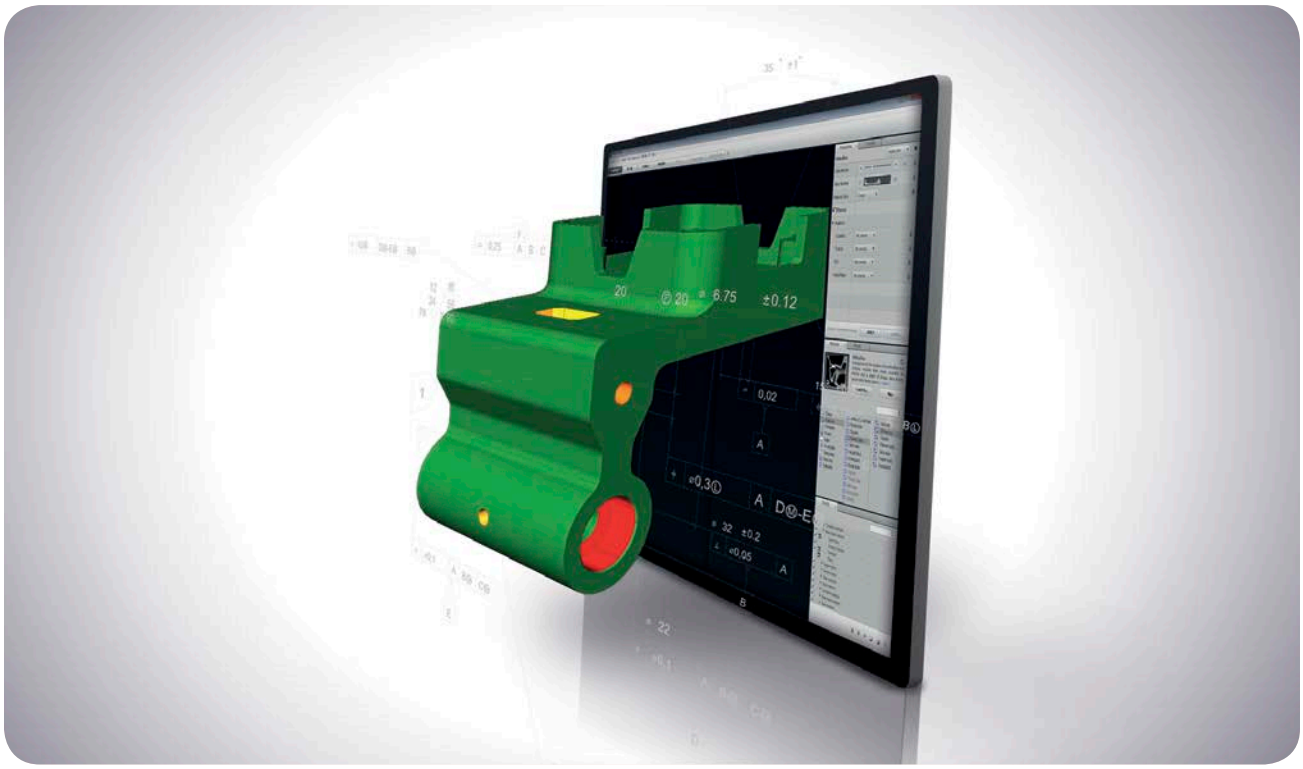
Open Inventor for Computer-Aided Design & Engineering

High-performance 3D graphics development toolkit

Open Inventor® is an object-oriented 3D graphics software toolkit for the development of professional interactive applications using C++, .NET or Java. Its easy-to-use API, its extensible architecture, and its large set of advanced components provide developers with a high-level platform for rapid prototyping and development of 3D graphics software applications for CAD & CAE.



Integrate 3D into your software for many phases of computer-aided product development:

- Computer-aided Design
  Mechanical - Electronic - Architectural
- Computer-aided Analysis
  CAE - CFD - FEA
- Computer-aided Review and Testing
  Digital mockup - Walk-through - NDT
- Computer-aided Manufacturing and Processing
  Machine control - Robotics - Facility management
- Computer-aided Documentation and Support
  Documentation - Training - Maintenance
- Marketing and Presentation
  Product literature - Websites - Presentations

↑ **CAD model** - Courtesy of Matthew Hewitt (matt.hewitt@live.co.uk)

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
- Integrated 3D computation framework

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

ABOUT OPEN INVENTOR

Open Inventor is a 3D software development toolkit (SDK). it is a set of high-level 3D software 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 3D data visualization 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.

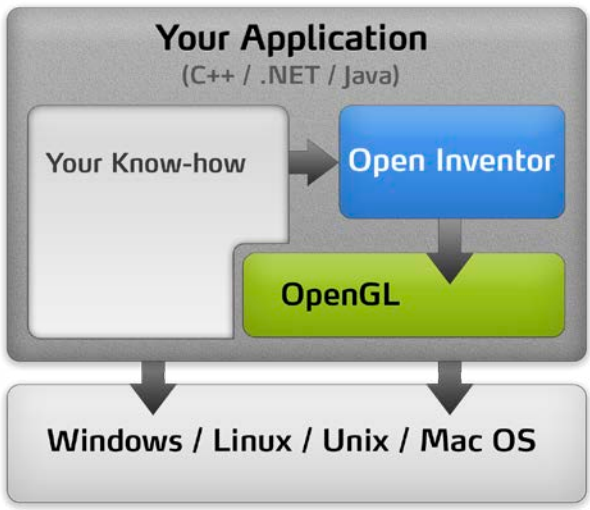
Volumeviz LDM. The VolumeViz LDM extension implements high-quality volume rendering, built-in modules for manipulating 3D-image data and a unique Large Data Management technology for out-of-core data support, up to hundreds of Gigabytes.

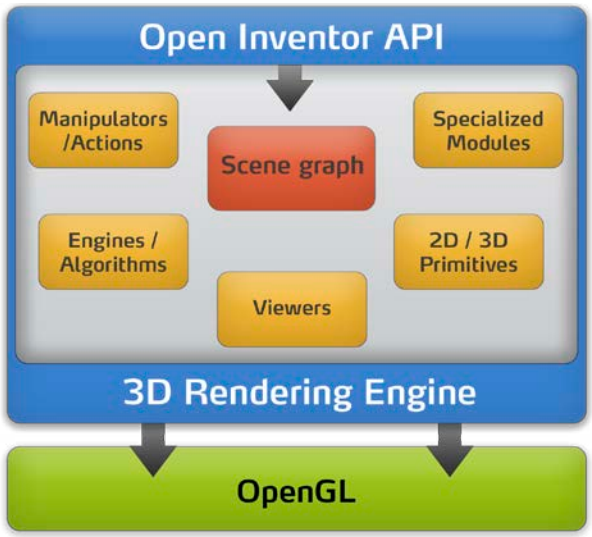
VolumeViz LDM delivers state-of- the-art image quality with the latest algorithms implemented on the GPU. It provides developers with high-level classes that efficiently implement standard visualization. Beyond volume visualization, the LDM technology enables access to out-of-core data with optimized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

Meshviz XLM. The MeshViz XLM 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 XLM 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 XLM offers a collection of high-level objects for implementing a wide range of charting types.

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.

Scaleviz. The ScaleViz extension provides a complete set of tools for distributed rendering on multi-GPUs configuration and on clusters. ScaleViz supports advanced depth and image compositing, multiple displays (tiled wall, CAVE®, etc.), as well as tracked input for immersive VR.





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 Open Inventor technology can be used to create high-performance software for computer-aided design and engineering.

We've come a long way since the days of paper drawings. And the world of digital product design continues to evolve rapidly. This evolution is driven generally by the continual increase in computing resources and specifically by allowing everyone in the product development chain to visualize engineering data and 3D images on their personal computing device. The classic engineering drawing displays the product in three views with dimensions and annotations. Through training and experience, users can learn to mentally visualize the actual product, but this process is inexact and error prone. The potential of computer-generated 3D visualization has always been clear, but the value often seemed limited by hardware cost, performance and unrealistic rendering. Today 3D hardware is cheap, fast, realistic and widely available. 3D visualization is accepted, even essential, in every stage of digital product design including design, analysis, review and testing, manufacturing and processing, documentation and support, and marketing and presentation. But there are still significant challenges in integrating 3D visualization in applications. Developers can minimize risk and maximize success by investing in high quality, proven 3D visualization middleware like Open Inventor.

Computer-aided Design. Mechanical design, electronic design, architectural design.
Computer-aided Design has to do with modeling of the geometry representing the physical product. Mechanical design software (MCAD) is used to design mechanical parts for many kinds of products ranging from appliances to aircraft to computers themselves. Electronic design software (EDA) is used to design electronic components including integrated circuits, printed circuit boards, computer chassis, wiring harnesses and more. Architectural design software (CAAD) is used to design all types of buildings including homes and offices, as well as industrial plants. Visualization for these design activities must be able to handle both very large objects (geometry) and very large numbers of objects in the same scene. Selection, highlighting and interaction with objects in the scene is critical. In many cases, semi-realistic rendering using lighting, shadows and programmable shaders is very important. In some cases photo-realistic rendering using ray tracing is required.

Open Inventor enables design applications to handle very large scenes with interactive performance through automatic optimization of 3D rendering, geometry culling and simplification, efficient use of system memory, multi-threading and GPU computing. Open Inventor rendering has all the geometry you need including triangles, lines, points, markers, images and NURBS with crack-free tessellation. Rendering features include transparency, lighting, shadows, antialiasing, stereo, customizable shaders, level of detail and fixed frame rate. For interaction, Open Inventor provides fast object selection using a click, a rectangle or a lasso, fast highlighting using boxes, color or transparency, convenient and customizable "manipulators" for modifying geometry, a "fast edit" feature for moving geometry even in very large scenes, and collision detection.

Computer-aided Analysis. Computer-aided Engineering, Computational Fluid Dynamics, Finite Element Analysis.
Computer-aided Engineering (CAE) has to do with modeling of the technology representing the physical science on which the design is based. In general there are three phases: pre-processing (creating the model), analysis (physics simulation using a solver) and post-processing (visualizing the results). CAE includes a wide range of analysis and simulation problems including electrical, magnetic, thermal, fluid and structural. 3D visualization is essential for pre-processing applications as discussed in the Design section. 3D visualization is also heavily used in post- processing to make sense of potentially many data sets containing many values over many time steps. The visualization system must be able to handle both changes in geometry (bending, deforming, etc.) and computed data sets such temperature and pressure.

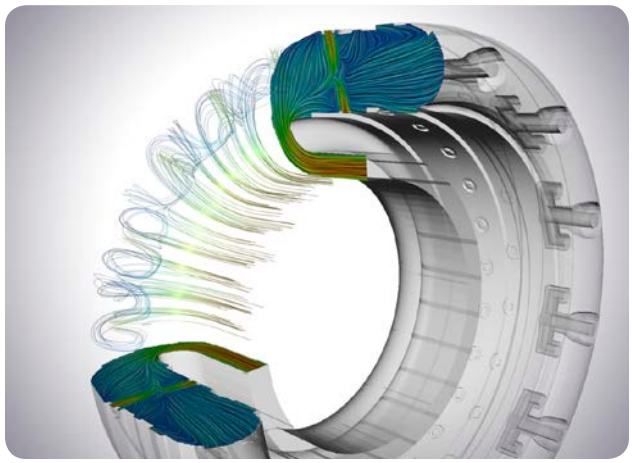
Open Inventor's MeshViz XLM extension is designed to solve these problems. Using an innovative "interface-based" API, MeshViz can handle very large meshes of almost any type and any data type because it avoids the need to make copies of application data. MeshViz supports both extraction and rendering of derived meshes representing slices, grid skin, isosurfaces, contour lines, stream lines and much more. For advanced solvers, MeshViz directly supports polyhedral cells and parametric cells (e.g. curved edges). MeshViz is multi-threaded and makes effective, scalable use of multi-core CPUs.

Review and testing. Digital mockup, walk-through, non-destructive testing, metrology.
Review and testing has to do with perfecting and proving designs for usability and quality. This encompasses a wide range of activities. Digital mockup for products and walk-through for buildings and plants allow design reviews without the cost of physical models. Non- destructive testing and metrology reduce the cost and increase the effectiveness of verification and quality assurance.

Open Inventor can render product models realistically using the powerful features of modern GPUs including transparency, antialiasing, lighting, shadows and custom shader programs. Open Inventor's DirectViz extension can even render photo-realistic images at interactive rates using a ray tracing renderer that takes advantage of modern multi-core CPUs. Open Inventor can render large building and plant models at interactive frame rates using level-of-detail and culling techniques. Open Inventor's ScaleViz extension supports complex display environments ranging from a wall of screens up to fully immersive virtual reality systems like the CAVE™. ScaleViz provides support for stereo, head tracking and tracked input devices, allowing you to support both desktop and VR environments with the same application and without additional VR libraries. Open Inventor's HardCopy extension can generate resolution independent 2D output suitable for printing or plotting on large format devices for review. For NDT and metrology, Open Inventor's VolumeViz extension handles 3D volume data from 3D scanners. VolumeViz handles large volumes, provides interactive performance and high image quality, and provides tools for clipping and masking volumes.

Manufacturing and processing. Computer-aided Manufacturing, Computer-integrated Manufacturing, robotics, facilities management.
Manufacturing and processing has to do with producing product and maintaining the production infrastructure. Computer-aided Manufacturing (CAM) uses computers to directly control machinery, such as milling machines, and uses 3D visualization for path planning and simulating results. Computer- integrated Manufacturing (CIM) uses computers to monitor and control the production process and uses 3D visualization to display the physical plant, animate processes and select objects. Robotics is a specialization of CAM and uses 3D visualization to plan and review robot movement. Facilities management is a growing user of 3D visualization to display and walkthrough facilities, highlight components that need attention, select components to query in the database, etc.

Open Inventor provides high-performance rendering with automatic optimization, as well as level-of-detail, culling and other techniques to optimize performance. Open Inventor provides functional building blocks called "engines" to help create animations of machinery and robots. CSG rendering or volume rendering can be useful to simulate the results of milling operations. Built-in collision detection can be useful to check fit and clearance for both static and dynamic scenes, for example robot arms. For existing facilities being modeled using laser scanners, Open Inventor provides high-performance rendering of point clouds.



↑ Courtesy of Turbomeca

Documentation and support. Product data management, product documentation, product training, product maintenance.

Documentation and support includes both internal and external clients. Internally the product development team needs to document and archive data from all the previous stages in the development chain (PDM). Externally the team needs to produce documentation for setup, installation and use of products, produce training materials to make users effective with the product and also to document maintenance procedures to keep products working in the field.

Open Inventor has its own compressed, binary file format that allows you to easily save your 3D geometry and scenes for re-use in other applications and viewers. Open Inventor can render images in JPEG, PNG and many other formats for inclusion in documents. Open Inventor allows you to create animations to show, for example, assembly or disassembly of a product. Animations can be exported in the standard X3D/VRML format and played in various 3D viewers. Animations, or human guided sequences, can also be rendered directly to MPEG video for inclusion in documents or web sites. Open Inventor can also export 3D geometry for inclusion in 3D enabled PDF files.

Marketing and presentation. Product literature, websites, presentations, trade shows.

Marketing is, in part, about making prospects aware of your product and making sure that the features and benefits are presented in a clear and compelling way. 3D visualization of the product, based on the geometry and data already used in previous steps of the product development chain, takes your marketing beyond text and bullet points. Marketing can make effective use of images, animations, video and even live 3D data.

Open Inventor can render images of any size, allowing very high resolution for everything from print media to trade show backdrops. These images benefit from all the image quality features discussed in previous sections such as transparency, antialiasing, shadows and shaders. Using a highly optimized ray tracing renderer, Open Inventor's DirectViz extension can produce photo-realistic images at interactive rates from the same scene graph your application builds to render on screen.

Open Inventor provides functional building blocks called "engines" to create animations that bring your product to life, fly the camera through the scene, etc. Open Inventor can render an animation or human guided sequence of actions directly to MPEG video to present your product in an engaging way. Open Inventor's HardCopy extension can export a 3D scene in the U3D format for inclusion in an Adobe® PDF file. Users can open these files in the free Adobe Acrobat® Reader and interact with the 3D geometry using Reader's built-in 3D viewer. Open Inventor's ScaleViz extension supports complex display environments like a wall of screens for trade shows or corporate centers.

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 that can be used throughout your Product Lifecycle Management processes.

Software vendors, corporate developers, research groups and innovative startups all utilize Open Inventor to integrate high-quality and high- performance 3D visualization 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.

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.

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 all be used to work with geometry or data, delivering a unique development framework to integrate synchronous high-performance computation tasks within an interactive 3D graphics application.

For basic geometry like points, lines, text, polygons and NURBS, core Open Inventor provides automatic optimization of both memory and rendering performance. Our graphics experts tune Open Inventor code to use the latest graphics hardware features and techniques so you can focus on application-specific code. Open Inventor uses multiple threads to accelerate CPU computation and also allows expert application developers to manage CPU and GPU memory in a convenient, device independent way. For complex data types like surface and volume meshes with associated scalar or vector data, the MeshViz XLM extension provides a unique interface-based API. MeshViz adapts to your application data structures, avoiding time

and memory consuming copies of application data. Efficient parallelized code extracts derivative meshes and visualizations optimized for fast rendering. For 3D volume data such as CT scans for material analysis and non-destructive testing, the VolumeViz LDM extension provides fast rendering, very high quality images and multi-resolution data management.

The ScaleViz extension is a set of technologies which implement rendering distribution on clusters and multi-GPU configurations along with scene and image compositing to solve the most challenging demands in visualizing very large data sets at interactive frame rates..

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, such as “jittering”, “faux shading”, adjustable “fast vs. high-quality” GPU-accelerated algorithms for lighting and shading, as well as image enhancement techniques, such as boundary opacity, edge coloring, 2D edge detection, and more.

In addition to the many built-in shader programs, VolumeViz (and more generally Open Inventor) allows the application to provide its own shader programs to implement specific innovations.

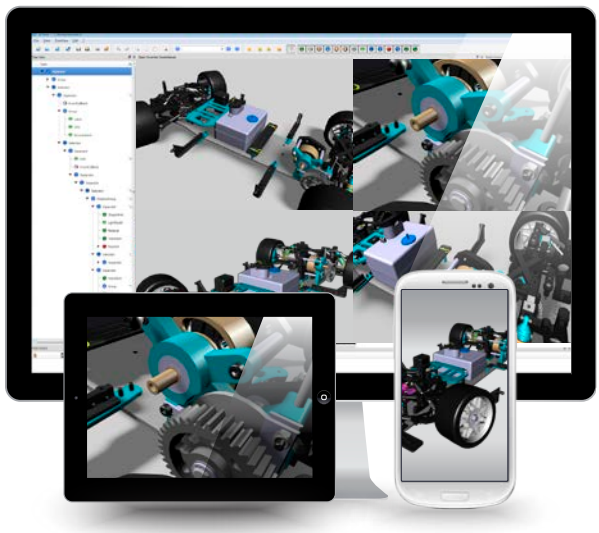
Mega-million cell data support. The MeshViz XLM extension has been designed to provide advanced support for mesh and grid data.

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 XLM 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 XLM 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.

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. For classical applications, Open Inventor is compatible with remote visualization solutions from vendors including Citrix and VMWare allowing running existing applications on distant display.

But you can also add an Open Inventor-based 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 INSIC

From the IPhone to Microsoft Surface, smartphones and tablet devices proved the value of multi-touch input. Open Inventor also allows developers to easily integrate multi-touch input in their 3D graphics applications.

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.

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 and Open Inventor rendering can be even be added to the scene in an existing OpenGL window.

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 that modify or replace the standard rendering pipeline. Open Inventor provides documentation and an internal API to minimize the effort to create custom nodes and custom shaders.

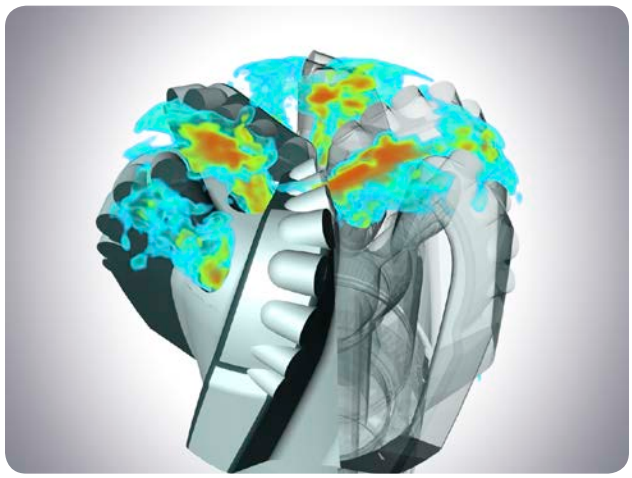
Strong support. Open Inventor is developed and maintained by a highly qualified professional team and is evolving on a regular basis, enhancing the product to integrate the latest techniques, address customers' specific requests and provide timely fixes for potential issues.

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, 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 across industrial sectors for over 15 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 industrial engineering to seismic interpretation 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



↑ Courtesy of Varel International

Power your software development with Open Inventor®

↑ Courtesy of OPEN MIND Technologies AG

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, efficient support for several-hundred-million cell 3D models, distributed rendering, 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, to system deployment and even cooperative R&D.

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

World Headquarters
Phone +1.503.726.7500

Visualization Sciences Group
Phone +33.(0)556.133.777

Learn more at OPEN-INVENTOR.COM
vsginfo@fei.com

FEI™