(intel®)
Software

Resolving the Challenges of CAD Format Conversion

Intel® Software Developer Tools, Intel® Parallel Studio XE, Intel® Threading Building Blocks, Intel® VTune™ Amplifier XE, Intel® Inspector XE
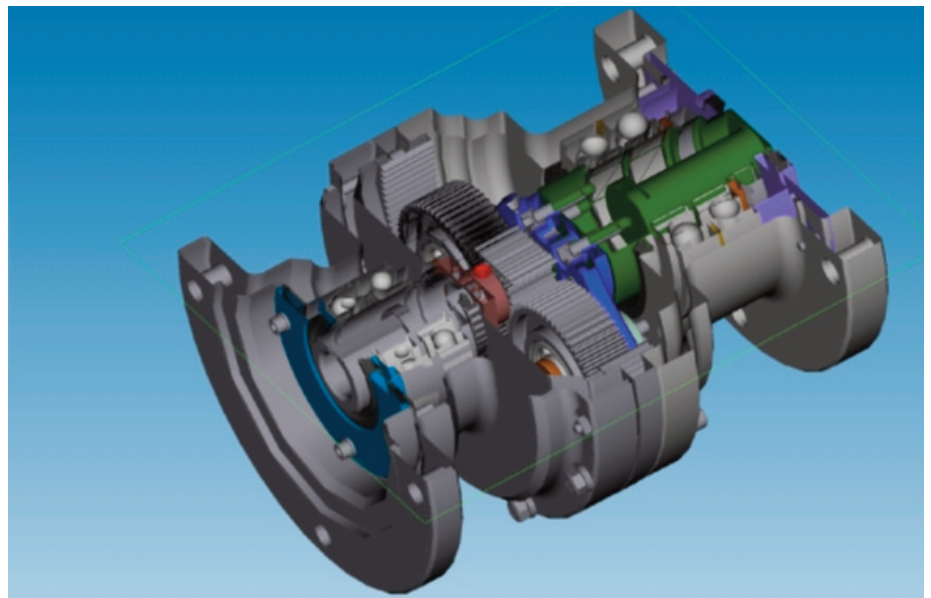
Computer-Aided Design (CAD)

CAD Exchanger
The easiest way to convert 3D data

Parallelism Brings CAD Exchanger* Software Dramatic Gains in Performance and User Satisfaction, Plus a Competitive Advantage

"CAD Exchanger* is broadly using multi-threaded algorithms to increase performance on multi-core systems," said Roman Lygin of CADEX, Ltd. "This is the key advantage over our competitors." Benchmarks show how it outperforms earlier editions in significant ways:

- **Some heavyweight computational algorithms**, such as blended surface approximation, were accelerated by 15X over single-thread mode.

- **Multi-threaded visualization** significantly increased the responsiveness of the GUI application, which in turn improved the user experience. Less time spent waiting means more time to interact and innovate.

- **Parallel file I/O** is 2.5× faster, and visualization time was reduced by up to 4X.

Developers of CAD Conversion Systems Look to High-Performance Computing Approaches
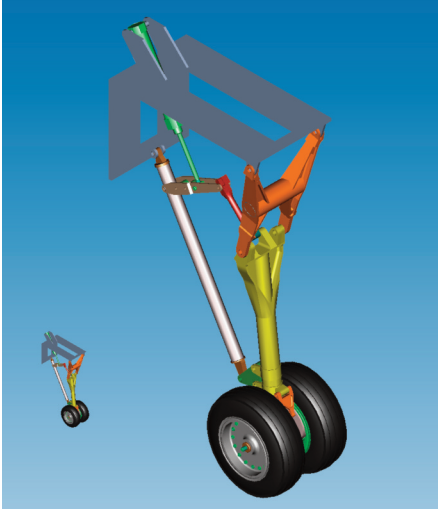
Introduction

Computer-aided design (CAD) is essential and widely used in many applications and industries such as the automotive, ship-building, and aerospace industries; industrial and architectural design; and computer animation and special effects for education and entertainment.

Now that the computing power to create vivid two- and three-dimensional representations is widely available, even simple products such as consumer goods packaging and small appliances are commonly designed with CAD systems.

Now imagine that the product under development is large and complex, such as an airplane, ship, or car. Its components are being developed by multiple vendors, each using its own CAD software, producing 3D models in different formats. How do you integrate those formats to facilitate collaborative work between the OEM and its suppliers? That's where CAD conversion software comes in, enabling users to view and convert files across different CAD formats.

The Challenges

Given the complexity of CAD systems, integrating diverse CAD files is no small feat, for several reasons:

- **Data diversity.** Conversion can entail translating various geometrical representations—wireframe, surface, or solid—as well as translating masses of related data, such as attributes, metadata, assembly structure, and feature data.

- **Rapid evolution.** The complexity of CAD data is continually on the rise. And software has to evolve with it. Legacy CAD conversion solutions can quickly become obsolete as standards change.

- **Data volume.** The growing volume of 3D data often drowns legacy conversion solutions, leading to inefficient processing, unacceptable wait times, and suboptimal results.

Developers of CAD conversion systems naturally look to high-performance computing approaches such as parallel processing to resolve computing bottlenecks. But parallelization of 3D model processing brings its own challenges for software developers:

- **Resource consumption.** The large variety of CAD formats and significant differences between them require a lot of resources to make them convertible.

- **High potential for errors.** Since linked lists and graphs are the most common data structures in CAD systems, there are heavy data dependencies. This structure limits performance scalability and generates a lot of errors, particularly data races (where two or more threads in a process access the same memory location concurrently with one access trying to write, and there is no process for handling conflicting accesses).

- **Workload imbalance.** Three-dimensional models have a complex and non-uniform structure, which leads to workload imbalance.

- **Slow response.** Poor data locality (where there is limited reuse of recently used data still in cache or data close to recently accessed locations) reduces the effectiveness of the cache, causing long stall times waiting for memory accesses.

> "I can't overstate the value of Intel® Inspector XE. It literally saved us several times with its ability to detect serious concurrency defects, help improve code, and remove risk."
>
> – Roman Lygin
> CEO
> CADEX Ltd.

The Solution

Roman Lygin, founder and CEO of Russia-based CADEX Ltd., welcomes a challenge. A software engineer for nearly 20 years—and a veteran of EADS Matra Datavision, Open CASCADE, and Intel—he founded CADEX in 2014 to create a product that would use today's technologies to help end users and software developers efficiently address the vital need of 3D CAD data access and interoperability.

With CAD Exchanger, vendors can efficiently bring diverse types of CAD data into a chosen standard. Not surprisingly, CADEX has a dynamic project with a growing customer base. The majority of its clients are small to large manufacturers, engineering companies, independent software vendors, and researchers who share the common challenges in 3D modeling, conversion, and visualization.

The CADEX team credits several Intel® software developer tools for playing a major role in the team's productivity as well as improving the robustness of CAD Exchanger products:

- **Intel® Parallel Studio XE** simplifies the design, development, debug, and tuning of code that efficiently uses parallel processing. It played a major role in boosting the CAD Exchanger team's productivity.

- **Intel® Threading Building Blocks (Intel® TBB)**, a component of Intel Parallel Studio XE, is an award-winning C/C++ library that enables high performance and scalability for parallel computing. Roman calls Intel TBB "the backbone of CAD Exchanger's parallelism" and relies on it for the building blocks of parallel 3D model conversion, asynchronous I/O, and concurrent visualization of 3D assemblies.

- **Intel® VTune Amplifier XE** is a performance profiler that provides rich performance insight into hotspots, threading, locks and waits, OpenCL, bandwidth, and more. The team relies on the tool to detect bottlenecks and analyze scalability.

- **Intel® Inspector XE** is an easy-to-use memory and threading error debugger used to identify issues such as leaks and allocation errors, deadlocks, and data races. No special compilers or builds are required, just a normal debug build.

Results

"CAD Exchanger is broadly using multi-threaded algorithms to increase performance on multi-core systems," said Roman. "This is the key advantage over our competitors. Another strong benefit is robustness to address missing or incorrect data, such as reconstructing 3D or 2D surface boundaries in the case of missing or inconsistent representations."

Roman credits significant performance and business benefits to each Intel® tool: "Using multi-core technologies enables dramatic increases in productivity. With the help of Intel Parallel Studio XE, CAD Exchanger became the modern tool for translating CAD data, while remaining an affordable, price-competitive solution for small to mid-sized businesses.

"Intel TBB makes CAD Exchanger efficiently scalable up to eight threads when converting complex 3D assemblies," Roman continued. "Intel VTune Amplifier XE is our workhorse for any performance analysis tasks. It enabled us to achieve significant performance gains.

"The TBB flow graph enabled us to introduce parallelism into two patent-pending, complex algorithms of processing tightly interconnected elements inside 3D models," Roman said. "Using the flow graph allowed us to make a big change with limited coding effort—an approach that was much more productive when comparing alternative implementations. I can't overstate the value of the Intel Inspector XE; it literally saved us several times with its ability to detect serious concurrency defects, help improve code and remove risk."

The CADEX Product Line

The company's flagship product suite, CAD Exchanger*, is a viewer and converter that supports the most widely used CAD formats such as IGES*, STEP*, JT*, ACIS*, Parasolid*, STL*, VRML*, and more. It efficiently exchanges product assembly structures, boundary and polygonal representations, properties, materials, colors, and other metadata.

Three editions are offered:

- **CAD Exchanger GUI*** is an intuitive, easy-to-use application for Windows*, Linux*, Android*, and other operating systems for end users to view and convert files across CAD formats. This graphical application supports visualization in shading, wireframe, and triangulation display modes; generates screen shots; and more.

- **CAD Exchanger SDK*** is a set of C++ libraries for software developers to use to import and export models in various CAD formats. Used by both the GUI and CLI editions, it can be integrated into third-party applications to support a desired format. The SDK makes it efficient to explore imported models and to create models from scratch, as well as applying different meshing techniques, including high-quality meshers.

- **CAD Exchanger CLI*** supports grouping of individual files into larger assemblies for export to multiple formats at once in background mode, especially for rapid, massive conversions.

Check out customer testimonials on the CADEX website: www.cadex-changer.com/customers.

In benchmark tests, CAD Exchanger outperforms earlier editions in many ways. For example:

- **Some heavyweight computational algorithms**, such as blended surface approximation, were accelerated by 15X in single-thread mode.

- **Multi-threaded visualization** significantly increased the responsiveness of the GUI application, which in turn improved the user experience. Less time spent waiting means more time to interact and innovate.

About CADEX

CADEX is a software company focused on delivering CAD/CAM/CAE products and services. Its flagship product suite, CAD Exchanger, enables CAD professionals to visualize and to convert 3D data across all major CAD formats including IGES, STEP, JT, ACIS, Parasolid, and many others.

Parallel file I/O is 2.5X faster, and visualization time was reduced by up to 4X.

"Intel's tools and libraries are making us more productive," Roman said. "We can achieve better performance results with moderate effort and resources. We couldn't make many of these optimizations if it took longer to complete."

Conclusion

"Existing customers and those evaluating CAD Exchanger consistently cite product performance, robustness, and ease of use as top competitive advantages," said Roman. "Several large companies have chosen CAD Exchanger over other solutions specifically for the performance gained from effective use of parallelism. Higher performance translates into better responsiveness and has improved the user experience. GUI actions take less time to complete, making user satisfaction yet another value of CAD Exchanger. Users agree. Don't take our word for it; check out the wealth of customer testimonials on the CADEX website: http://www.cadexchanger.com/customers.html."

Learn More

CADEX: **www.cadexchanger.com**

Intel® Parallel Studio XE: **software.intel.com/en-us/intel-parallel-studio-xe**

Intel® VTune™ Amplifier XE: **software.intel.com/en-us/intel-vtune-amplifier-xe**

Intel® Inspector XE: **software.intel.com/en-us/intel-inspector-xe**

Intel® Threading Building Blocks: **software.intel.com/en-us/intel-tbb**