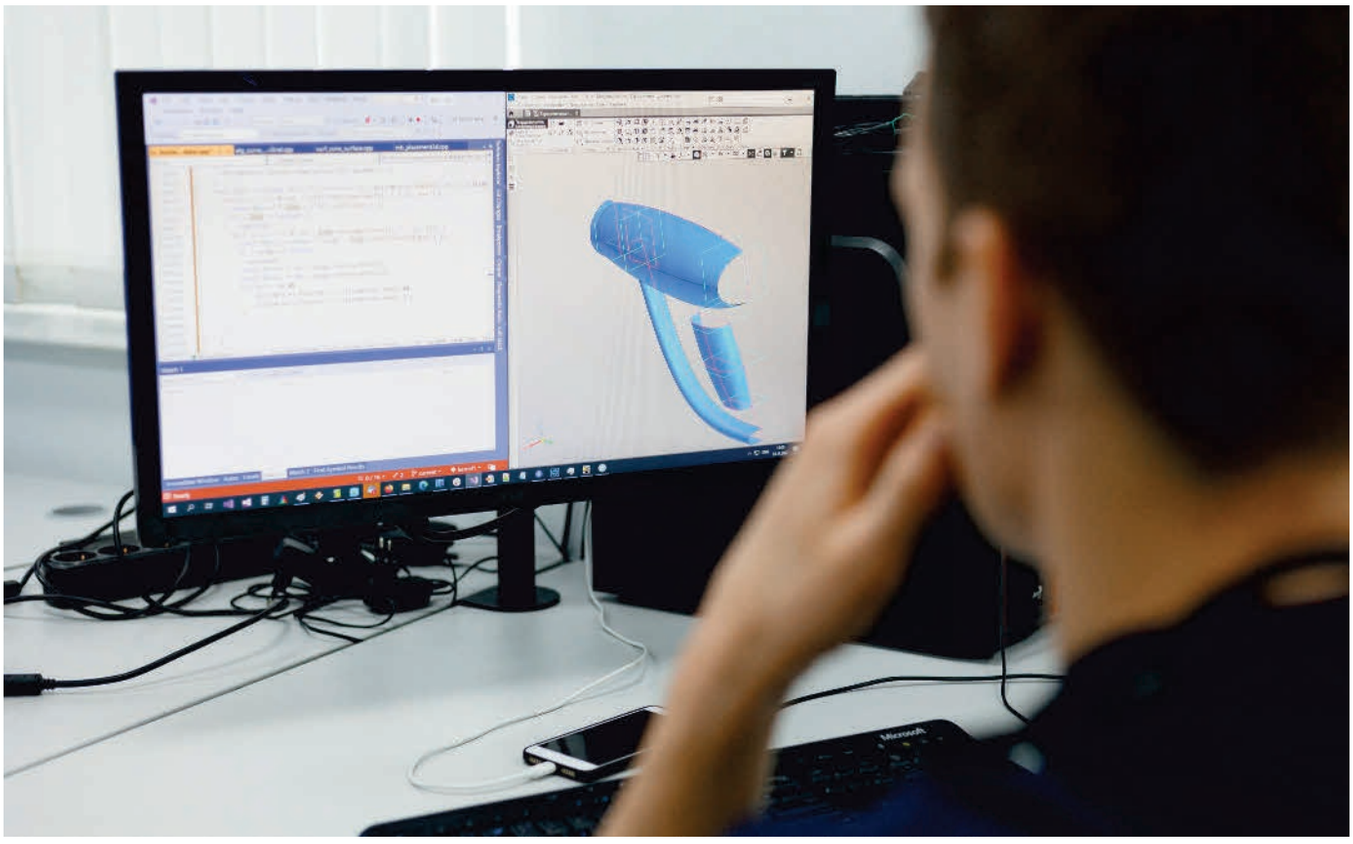
C3D Labs Solutions

The Most Complete Solutions for Developers Creating Innovative 3D Software

C3D Labs

About company



The geometric kernel has been developed by an experienced team of Russian mathematicians since 1995. C3D Labs as a company was founded in 2012.

Its role was to convert the 3D kernel into a software development kit (SDK); to turn it into a standalone product; and to market it internationally. The result is the "C3D Toolkit", built on renowned Russian mathematics and with nearly thirty years' experience in working with advanced CAD components.

C3D Toolkit components are now used by more than 60 companies in 14 countries around the world. As customers today develop projects based on our C3D Toolkit, we work closely with them to ensure they have what they need. We are regularly praised for our wide range of functionality, reliable support, fast feedback on requests and flexible licensing terms, which we customize for each customer:

+ commercial license for vendors;
+ special license terms for startups;
+ corporate licenses for enterprises;
+ academic programs for universities.

C3D Toolkit

C3D Toolkit is a software development kit (SDK) responsible for constructing, editing, visualizing and converting geometric models

C3D Toolkit allows to construct geometric models, perform geometric calculations, and create connections between the elements of geometric models. C3D Toolkit allows to handle geometric models made in third-party applications and performs export models to other 3D systems.

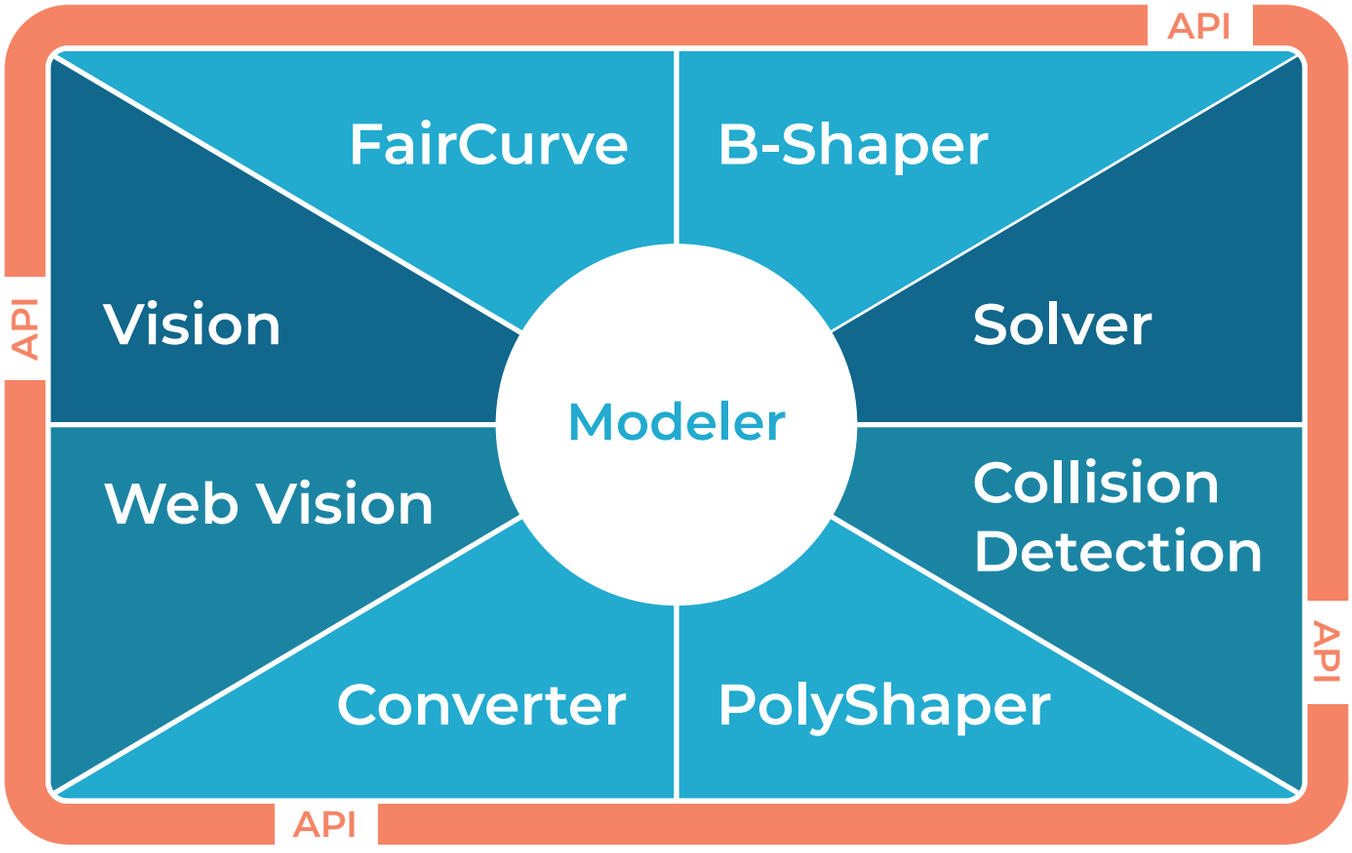
Computer-aided design (CAD) systems are the most widely known software products that require tools like C3D Toolkit for their development. Such tools are also used in computer-aided manufacturing (CAM), and engineering (CAE).

CAD/CAM/CAE systems all use the same approach to geometric modeling. A model contains:

+ describing the shapes of modeled geometric objects;
+ maintaining relations between model elements;
+ recording the history of model construction;
+ adding attributes to geometric model elements.

In addition to geometric modeling functionality, C3D Toolkit offers advanced model rendering capabilities in the graphical scene using a powerful visualization engine. These visualization capabilities can be used to develop both desktop and web applications.

C3D Toolkit comprises of a dynamic-link library, a demo application with complete source code, technical documentation, and additional support files for compatibility with many integrated development environments (IDE).



The amphibious aircraft «BOREY»

Request
C3D Toolkit trial version

C3D Modeler

The reconstruction of the aircraft «Po-2»

Implement efficient 2D and 3D geometric modeling tools in your applications

C3D Modeler performs all geometric calculations necessary for constructing 2D sketches and 3D models. It uses the boundary representation (B-rep) method in defining shapes and building geometric models based on 3D bodies. For composing 3D bodies, it uses surfaces and curves. It groups the resulting 3D bodies into building blocks in advance of creating more complex assemblies.

In addition to B-reps, polygonal representation is also available. Polygonal models consist of approximated faces and polygons. They are convenient for analysis and visualizations.

As bodies and wireframes are constructed into geometric models, they generate individual build logs. The system records all of the methods employed, sequences taken and data in putted. The logs make it easier to edit the geometry later and then rebuild models with new parameters. Detailed information about objects' geometry (in the form of surfaces, curves and points) are kept in topological elements of model's objects such as faces, edges and vertices.

Additional information for every object's item or object as whole can be kept inside them in the form of attributes.

Tested & Validated Daily
To enhance C3D Modeler quality, we employ a number of testing tools and methods. These include static code analyzers, unit testing, performance testing, automatic distribution of package assemblies and automated regression testing. To test our solid body and surface construction algorithms, we use a specially created database that contains over 500,000 of 3D models. Every day, we automatically compile the geometric kernel, as well as perform unit test checks, model rebuilding testing, flat projection construction testing and data conversion testing.

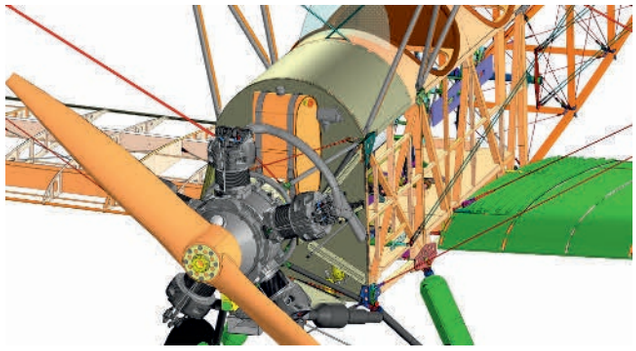
ExpandableAPI
An essential feature of the C3D Modeler is its open architecture, which allows you to extend it beyond the standard function set. You create custom objects that are specific to your application by easily inheriting them from C3D Modeler's standard primitives. When this is combined with our safe update system (which runs independently of existing code), you are assured that version updates will not affect the functions you extended.

C3D Modeler Functionality

Solid modeling operations:
+ Boolean;
+ extrude, revolve, sweep;
+ thin-walled bodies;
+ fillets and chamfers;
+ face tapering;
+ ribs.

Wireframe modeling operations:
+ curves;
+ intersection of curves;
+ extend;
+ trim;
+ unwrapping;
+ equidistant curves;
+ outline curves.

Surface modeling operations:
+ extrude; revolute, sweep;
+ loft, surface based on a curve grid;
+ equidistant surface;
+ trim/extend;
+ fillets;
+ patch, stitch.



Direct modeling operations:
+ remove faces;
+ change the fillet radius;
+ replace face;
+ move/rotate face;
+ resize face;
+ merge smoothly jointed faces;
+ resize holes.

Sheet modeling operations:
+ bend/unbend;
+ convert solid to sheet metal;
+ stamp;
+ rolled sheet metal;
+ bend relief;
+ louvers;
+ reinforcement rib.

C3D Modeler supports the following geometric calculations:
+ surface areas, volumes,
+ and properties of mass inertia;
+ building planar projections;
+ generating surface triangulations.

C3D Modeler supports much more operations. For the full list please visit the Developers section at c3dlabs.com

C3D Solver

Define dimensions and constraints to create connections between geometric elements

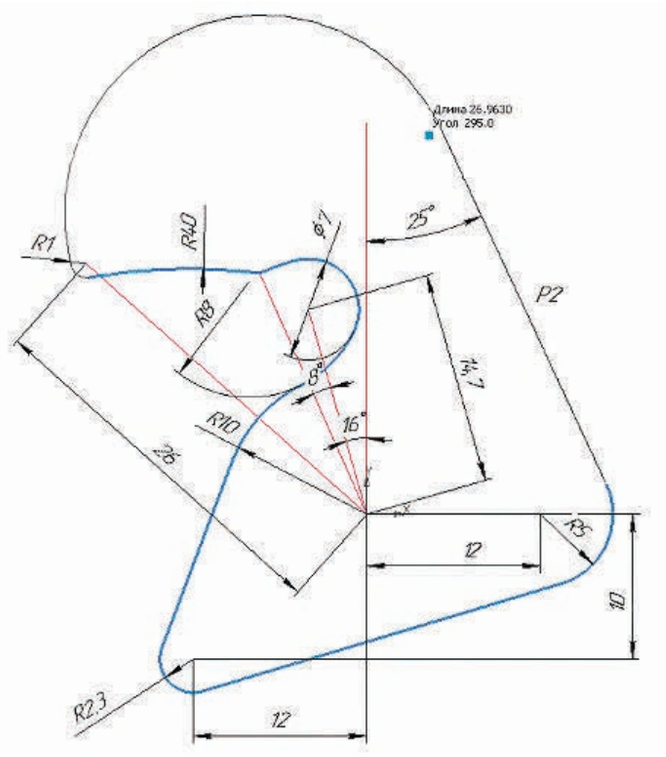
Constraints represent all relationships among geometric objects in 2D/3D applications. These include dimensions that define angles and distances and logical constraints that define concepts like a coincidence, parallelism, perpendicularity, tangency, etc.

Using C3D Solver, developers incorporate dimensions and logical constraints in their applications to create connections between geometric objects in 2D and 3D models. C3D Solver maintains constraints as users make changes to the geometry. For example, when users modify dimensions, C3D Solver instantly recalculates all depending geometric objects and maintains existing relationships.

Our C3D Solver reduces 2D/3D modeler development costs significantly, as the constraint engine is readymade for you. You can plug the C3D Solver in at any stage of your product development cycle.

High Performance

C3D Solver was written for performance, and we are always working at finding new ways to further speed up the code by simplifying the moth, dividing analysis into sub-tasks, using large sparse matrices, and so. One key productivity boost, for instance, is the Planner, which extracts from the entire set of constraints a smaller subset sufficient to do the job.



The demonstration of dragging on a sketch

Live Constraint Verification

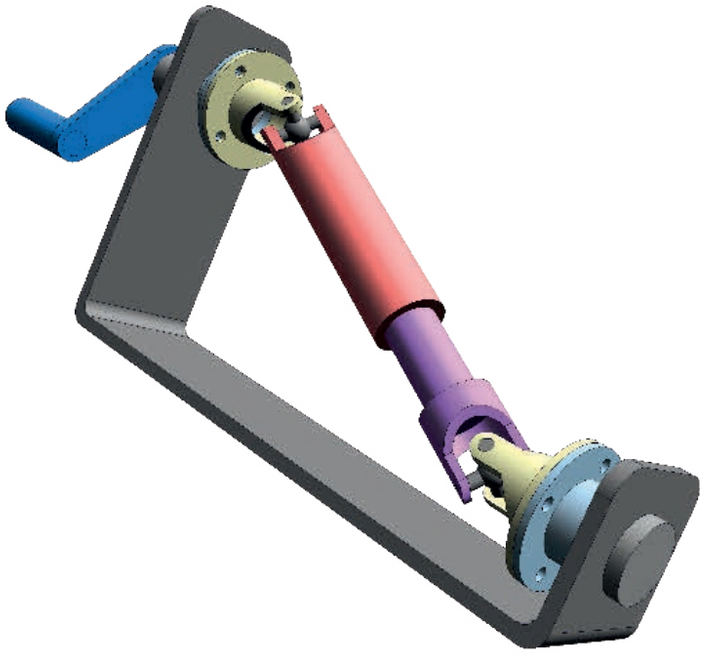
Splitting the initial model of constraints into sub-tasks not only improves the speed at which the solution arrives but also identifies a wide variety of situations in which the built-in diagnostics avoid contradictions in the system of constraints. This assists users in constructing high-quality parametric models without avoiding contradictions in the system of inconsistence.

Browser-Ready

Porting the 2D solver to JavaScript unveils new application possibilities for C3D Solver, such as the development of cloud solutions for doing online sketches, interior planning with driving dimensions, and so on. This makes it possible to quickly implement a 2D drawing editor in a browser complete with dimensioning and constraints. Perhaps most significantly, the 2D solver for JavaScript is a platform-independent solution.

C3D Solver Applications:

+ creating 2D parametric sketches with driving dimensions and constraints;
+ positioning bodies in assemblies using constraints and dimensions in 3D;
+ rebuilding changed models while keeping previously defined constraints intact;
+ modeling planar and spatial mechanisms;
+ creating 3D wireframes.



Cardan joint

Functionality:

+ creating and solving parametric constraints; manipulating geometry;
+ dragging geometry;
+ satisfying constraints;
+ analyzing degrees of freedom (2D only);
+ clustering rigid sets (3D only);
+ journaling API calls.

Dimensional Constraints in C3D Solver:

+ by dimension type: linear, radial, diametral, angular, curve length;
+ by dimension calculation type: driving, interval and variable dimensions.

Logical Constraints in C3D Solver

General:

+ coincidence;
+ fixed geometry;
+ parallelism;
+ perpendicularity;
+ reflection symmetry;
+ tangency.

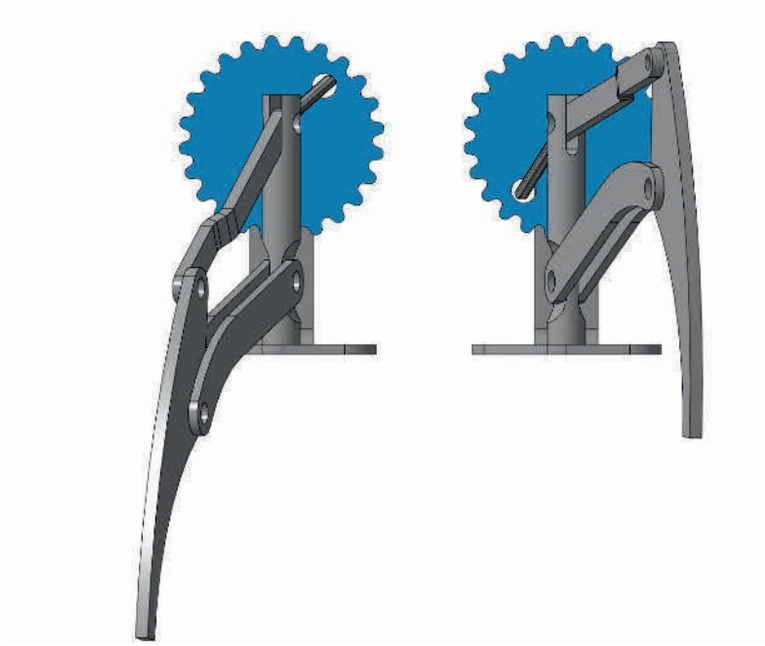
2D Constraints:

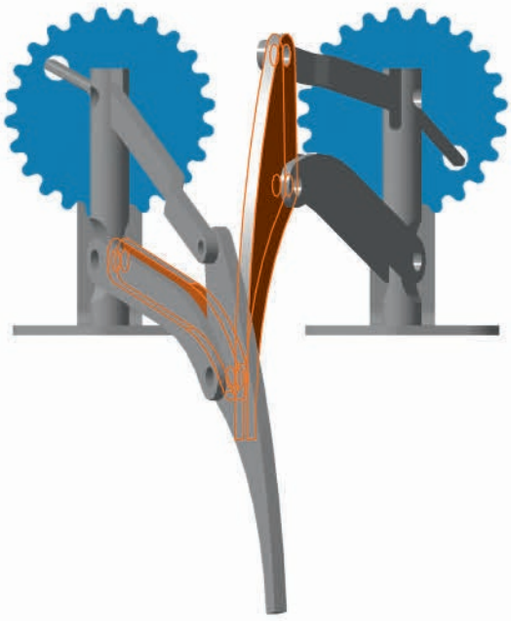
+ alignment;
+ point on a curve;
+ equal length;
+ equal radii;
+ fixed length and direction;
+ fixed spline derivatives;
+ horizontal position;
+ vertical position;
+ bisector;
+ smooth Gl and G2 transitions;
+ offset curves.

3D Constraints:

+ coaxiality;
+ user-defined dependencies;
+ linear and angular patterns;
+ mechanical transmissions;
+ cam mechanisms;
+ rack and gear mechanisms.

C3D Collision Detection





The model shows the kinematics of the walking robot

Rapid collision/gap detection for solid models, support for both exact B-rep geometry and approximate polygonal meshes

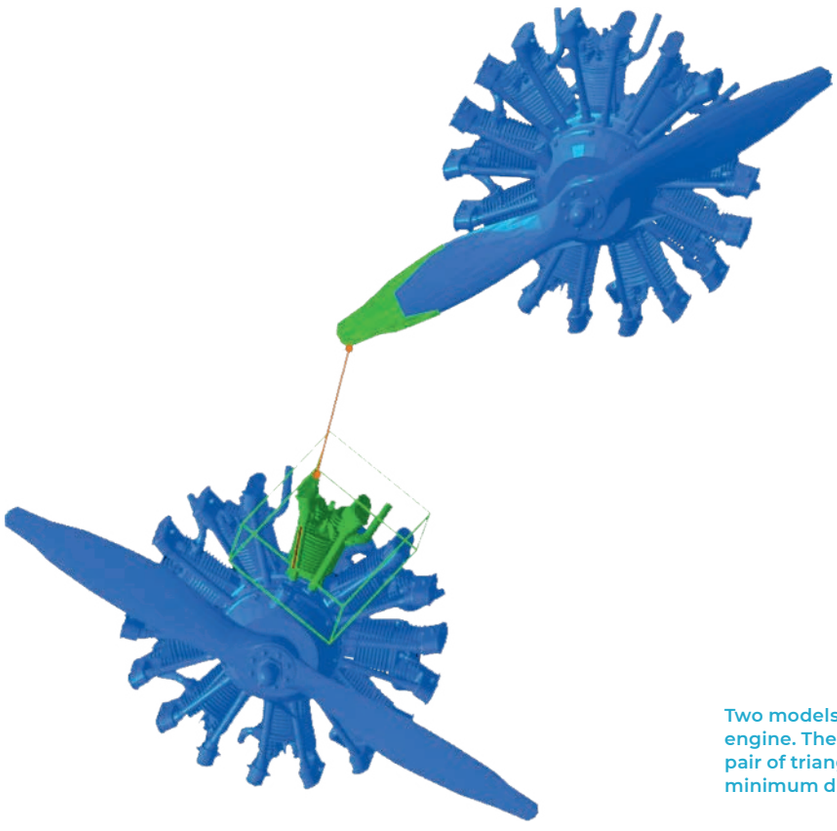
Integrity of Assemblies Guaranteed
All assemblies should be free of collisions between their components.

With our Collision Detector, your CAD and BIM applications check assemblies for collisions at early stages, prevent assembly or kinematics errors. Early detection of collisions reduces manufacturing costs.

The distance measurement function checks user-specified gaps between parts and sub-assemblies.

Static and Dynamic Operations
Distance and clearance measurements, along with collision detection, are available for both static assemblies and dynamic sequences, in which users move parts of mechanisms interactively.

Support for B-Rep and Polygonal Geometry Representations
Collision Detector works accurately with B-rep geometry. If necessary, polygonal representation can be used to speed up the analysis.



Two models of the aircraft piston radial engine. The algorithm applied calculates a pair of triangles and points on them with a minimum distance

Fast Performance

Our Collision Detection quickly identifies entities that collide with one another, if any. To improve performance, the detector applies bounding volume hierarchy (BVH) technology to individual solids and sub-assemblies. To further boost performance, it optimizes memory management, such as when assemblies contains multiple instances of the same components.

Flexible Detection Options

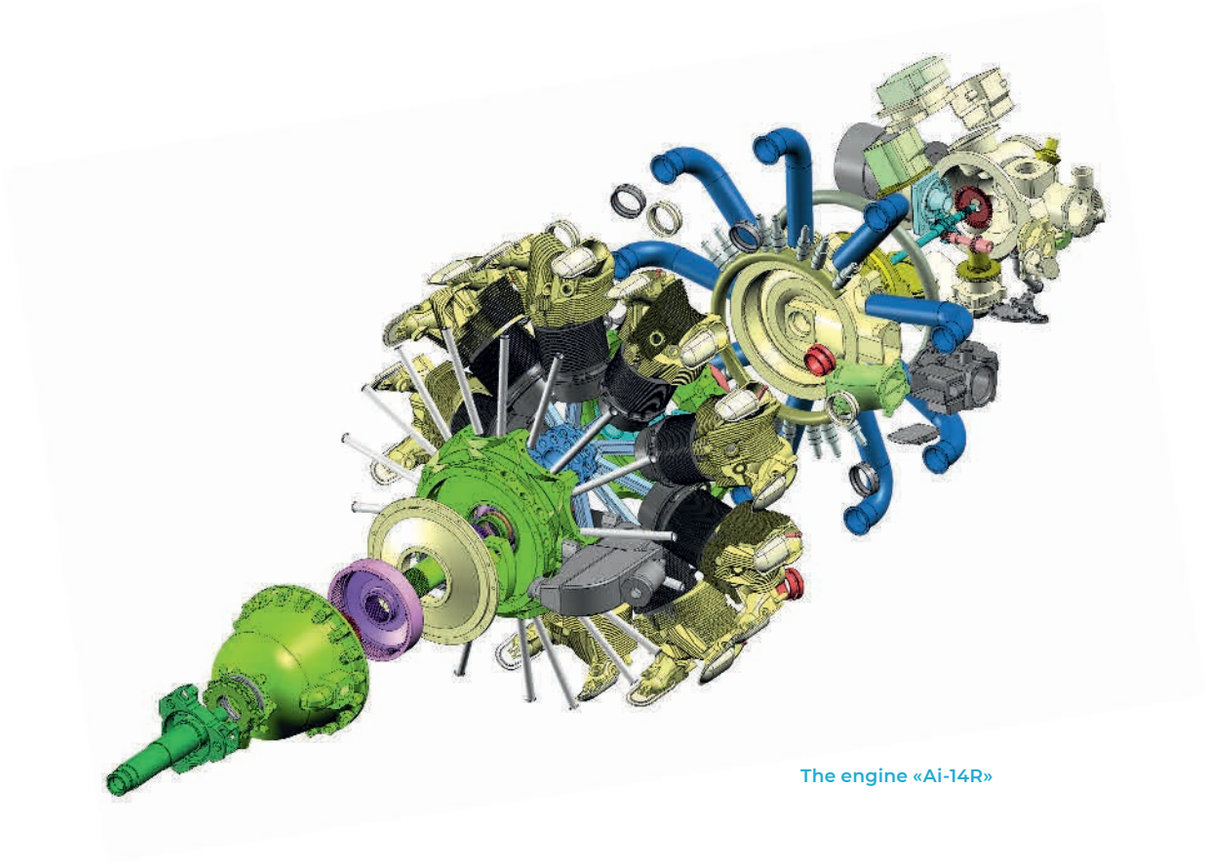
Collision Detector can be configured to limit the scope of detection.

For example, you may need to detect all faces where the bodies intersect. or you may just want to know whether bodies or subassemblies collide without going into the details. You can also exclude some pairs from the detection and select from a range of collision detection strategoes. The detection results can be tangents or in-volume intersections.

Scene Structures

Scenes consist primarily of solid shells that can be arranged hierarchically. The data structure of our Collision Detection accounts for multiple shell instances. As well, it can merge bodies into groups to treat several solids as a single one, so that collisions are detected between groups and not within the groups, further saving time.

C3D Vision



The engine «Ai-14R»

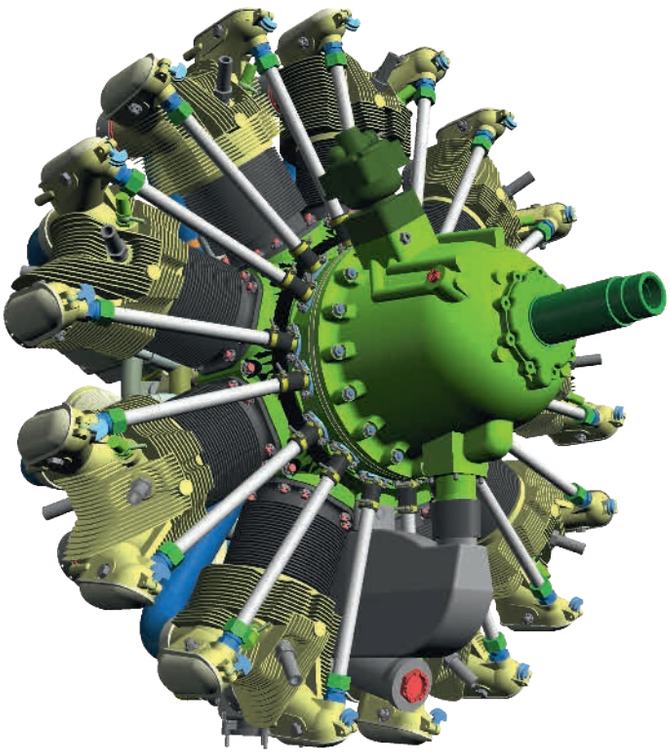
Manage visualization capabilities of 3D geometric models in yourengineering software

Using C3D Vision, software developers can customize visualization parameters of displayed 3D geometric models in their applications. C3D Vision allows developers to control rendering quality of geometric models by using advanced moth, software and hardware means so that It improves large-assembly performance.

C3D Vision yields new opportunities for managing 3D scenes, animations, provides ready-to-use tree for 3D models and interactive tools for scene manipulation. All of these functions became an integral part of modern design products.

C3D Vision capabilities:

+ render any polygonal representation;
+ user interaction with the model;
+ camera control to display the scene;
+ adding annotation objects;
+ SW/HW accelerated visualization;
+ integration with C3D Modeler objects;
+ support for a ranger of video adapters.



The engine «Ai-14R»

Designed for engineering visualization in CAD/CAM/CAE/BIM applications

The visualization module is intended for CAD and similar applications. C3D Vision provides a range of tools for quick software development:

+ object search, filtering by type and primitives;
+ search for model objects under the cursor;
+ handles and manipulators to interact with the model;
+ measurements: linear, radial and angular dimensions.

Integrated Environment

C3D Vision is closely integrated with the C3D Modeler geometric kernel. To automatically generate scene graphs based on mathematical models, it is sufficient to call just one function. There is the option to calculate polygonal models for visualization objects (based on math representation of the geometry) in synchronous or multithreading mode.

Performance optimization

For high performance with scenes and large models: hardware acceleration estimating the visibility of the scene objects by specifying object sizes in screen pixels estimating the visibility of the off-screen objects adjustable LOD (levels of detail).

C3D Converter

The air boat «Skat»

Import and export models and attributes into and from your applications

C3D Converter reads and writes 3D models in CADneutral formats. It handles geometry, authoring info, part names and IDs, and PMI (product manufacturing information).

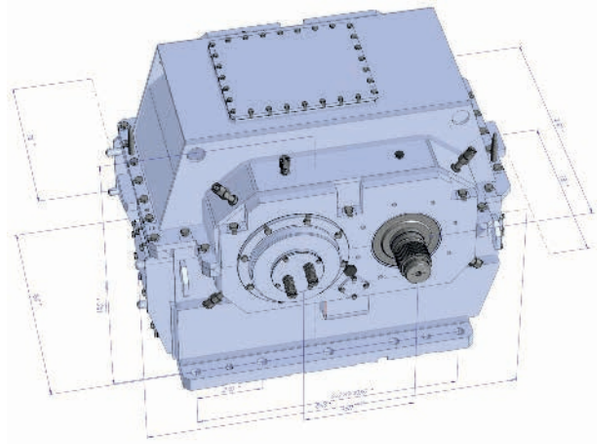
C3D Converter is eminently configurable, such as in controlling automatic stitching of surfaces into shells, and filtering entities by type. Refer to the documentation for all settings currently implemented. A built-in debug functions allow to prepare and send back problematic data to C3D Labs confidentially for analysis and further improvement of the converter; your files are not shared with anyone.

C3D Converter supports memory operations in those cases when reading and saving CAD-neutral formats would incur performance issues. For better performance, our STEP and Parasolid converters employ multithreading.

Support for Exchange Formats

C3D Converter can export and import geometry from/to most commonly used exchange formats available under a common license. The choice of an exchange format depends on the specific model representation or end user demands. The supported formats are carefully selected for your better experience.

Buggy, the car



The multiplier

File Import Plugins

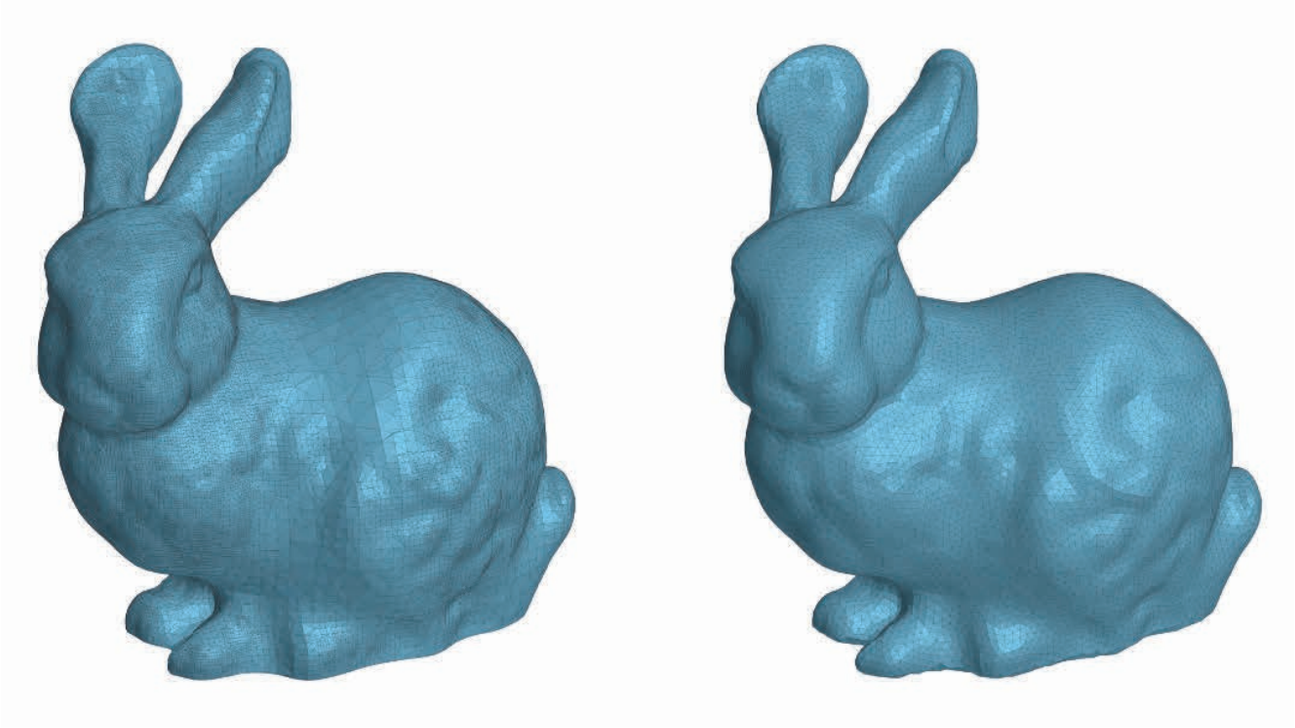
We also support plug ins, which are a fast and efficient way to import 3D models not supported directly by C3D Converter.

Depending on the capabilities of the format, the following are transmitted:

- shape in various representations (volumetric objects, surfaces, curves, points);
- assembly structure, including deep nesting and reference geometry;
- technological information - annotations and numerical specifications (PMI, GD&T);
- attributes - visual, named in name-value representation.

Format	Read	Write	Additional licence required
C3D	✓	✓	
STEP (AP203, AP214 и AP242)	✓	✓	
IGES 5.3	✓	✓	
ACIS (SAT)	✓	✓	
ACIS (SAB)	✓		
Parasolid (X_T, X_B)	✓	✓	
JT	✓	✓	
VRML 2.0	✓	✓	
STL	✓	✓	
3MF	✓	✓	
OBJ	✓		
NX v2004-2023	✓		✓
SolidWorks v2007-2024	✓		✓
Creo (ProENGINEER) v2002-2023	✓		✓
CATIA v2003-2023	✓		✓
Inventor v2010-2024	✓		✓
Solid Edge 2009-2024	✓		✓
IFC (2X3, 4, 4X3)	✓		✓

C3D PolyShaper



The Stanford bunny
Computer Graphics Laboratory
Stanford University

The polygonal representation uses vertices, edges, and flat facets to build faceted 3D bodies. You can use C3D Converter to read/write such models, and C3D Vision to visualize them. C3D PolyShaper is a toolbox designed to edit, analyse and heal polygonal objects.

Diagnostics and Healing
Polygonal meshes may have geometric and topological issues. The list of geometric model errors can be extensive, including such issues as gaps and openings, duplicated vertices, degenerate triangles, and non-manifold geometry. and so on. Such errors can cause most algorithms to fail. Diagnostics and healing are essential stages in polygonal modeling.

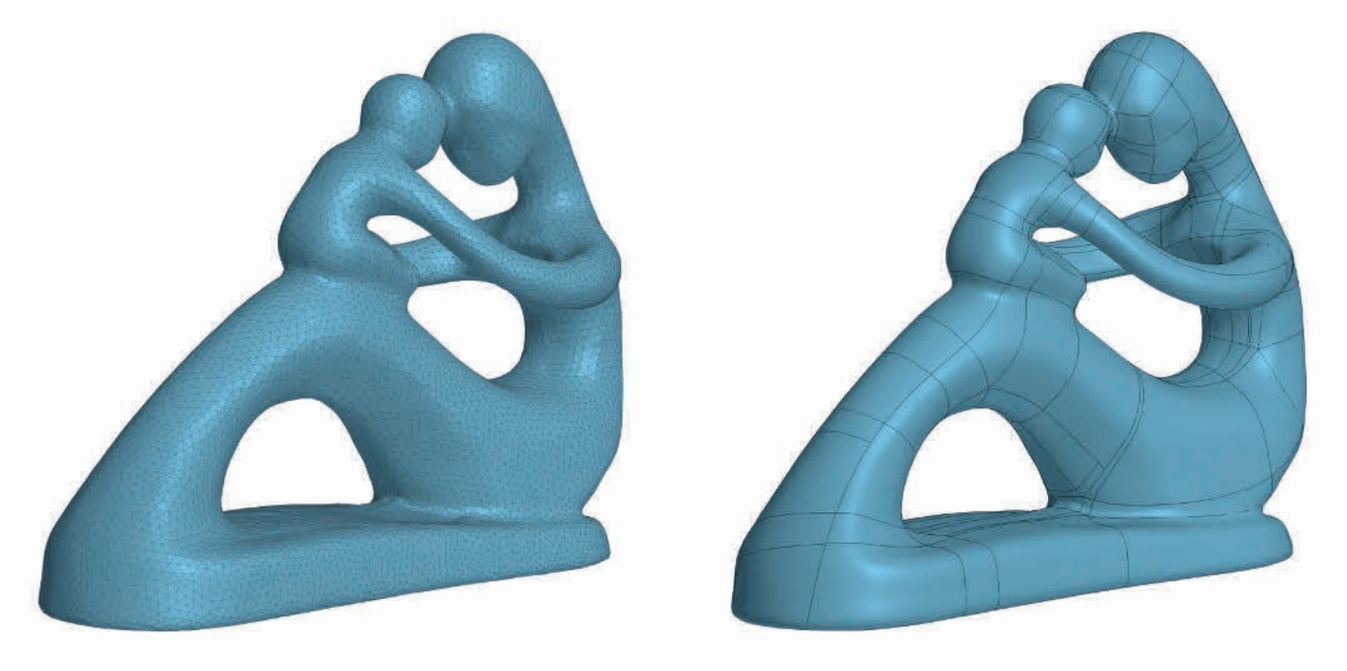
C3D PolyShaper others:

+ mesh diagnostics;
+ fixing degenerated triangles;
+ mesh stitching;
+ fixing inconsistent normals;
+ checking for non-manifold geometry.

Simplification, Refinement, and Remeshing of the Triangulation Mesh
Reducing the number of triangles improves the performance. C3D PolyShaper has two mesh simplification options: to a given number of triangles or a given accuracy. One can obtain a set of simplified meshes with different levels of detail. The simplification algorithm guarantees the preservation of the topological properties of the polygonal object.

The reverse local mesh refinement tool is used for computer-aided analysis to enhance the local simulation accuracy. It preserves a smooth transition from larger to smaller triangles.

Remeshing improves the mesh quality by making the triangles as equilateral as possible. Better mesh contributes to the reliability of many algorithms and simulation processes.



Fertility
AIM@SHAPE-VISIONAIR Shape Repository

Editing

C3D PolyShaper offers the following polygonal mesh editing tools:

+ deleting triangles;
+ Boolean operations;
+ plane sections;
+ mesh trimming by a cube of a specified size.

Polygonal Model Analysis

C3D PolyShaper can validate meshes generated by 3D scanning, topology optimization, and other methods.

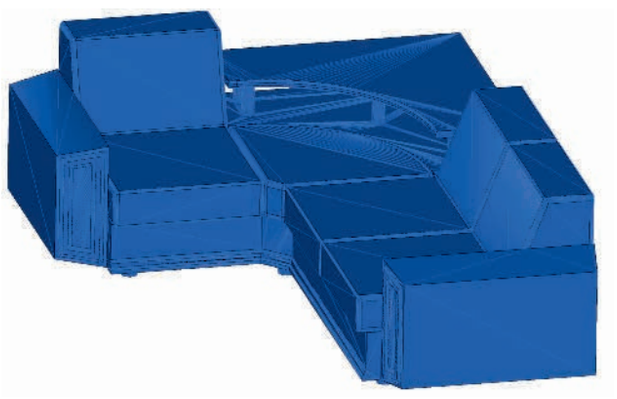
When it is known in advance that objects should match (for example, when comparing a CAD model to a 3D scanned model), we can apply automatic or semi-automatic object matching for subsequent comparison.

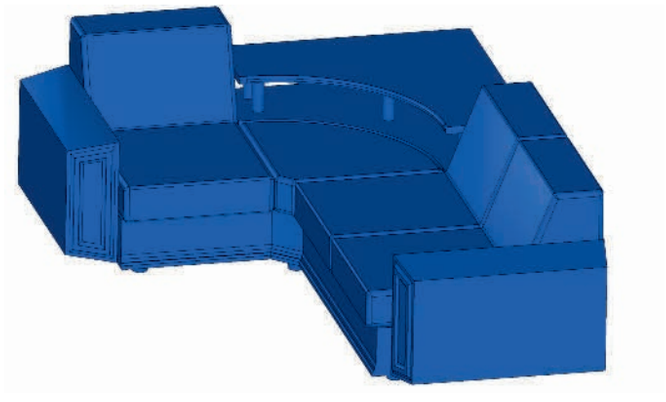
Another approach is reverse engineering when a polygonal model is converted into a solid. For this, analytic surfaces are approximated with the least squares method. The surface type is either autodetected or selected by the user, such as plane, cylinder, cone, sphere, or torus. The mesh sensitivityto noise can be adjusted to meet various criteria. The shape control tool aims to prevent the creation of surfaces that are close to degenerate, such as nearly flat or nearly cylindrical cones. The inputs are a set of triangles and the desired accuracy.

Another area involves the automatic conversion of mostly free-form models into a shell composed of NURBS patches.

As a rule, what we require is not just the mesh itself, but rather the mesh with its facets logically divided into some groups. The segmentation builds the topology of the polygonal model similar to conventional B-Rep models. The difference is that the faces consist of connected groups of facets, while the edges are composed of sequences of mesh edges. Each topology segment may have an attribute. The attribute can be a number, vector, surface, or arbitrary data structure.

C3D B-Shaper





«Sofa», as a component
of the model «Dom na ostrove»

Add the capability to handle polygonal model reverse engineering to your applications

The C3D B-Shaper converts polygonal models into solids with boundary representation. Boundary representation is the basis for 3D modeling in most modern 3D engineering applications. Emergence of models in polygonal representation is promoted by the spread of 3D-scanning technologies,development of control and measuring equipment, necessity to process results of generative design

C3D B-Shaper Converts Polygonal Meshes Into B-rep Models:

+ automatic or interactive mesh segmentation: surface approximation by polygons with adjustable accuracy;
+ B-rep model generation.

Proprietary Math
C3D B-Shaper uses our unique algorithm to subdivide meshes into subsets that are then converted into faces. Subsets are recognized as either elementary surfaces (plane, cylinder, cone, sphere, torus) or free surfaces (NURBS). The module generates intersection curves between adjacent subsets, which then become body edges.

Boosted Performance
When handling multiple imported polygonal models, C3D B-Shaper accelerates the analysis and simplifies visualization which results in better overall performance.

Adjustable accuracy
The accuracy of C3D B-Shaper's results is specified by a maximum-acceptable deviation of the reconstructed surface from the vertices of the underlying polygonal mesh.

«Guitar», as a component of the model «Dom na ostrove»

B-Shaper is built on C3D Labs' proprietary algorithms and makes polygonal models useful to many kinds of applications:

+ reverse engineering parts from 3D scanner files;
+ converting models from online component/ typical catalogs for manufacturing and construction sectors;
+ topology optimization post-processing in CAE applications.

B-Shaper capabilities:

+ control the surface recognition accuracy;
+ segmentation of polygonal meshes;
+ segmentation editing: merge, split, etc.;
+ reconstruction of a predefined surface on a segment;
+ generate B-rep models.

Through its API, C3D B-Shaper operates in two modes:

+ automatic: generates acceptable results for highquality polygon meshes, which are usually triangulations of CAD models that mostly contain elementary surfaces;
+ interactive: when a polygon mesh is constructed from 3D object scans and contains arbitrary surfaces.

C3D FairCurveModeler

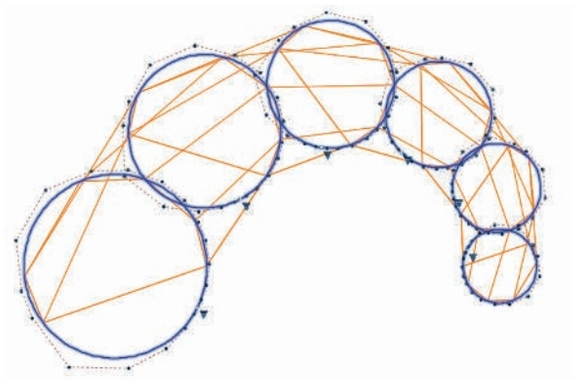
There is demand today for CAD systems advanced enough to model complex curves and surfaces, such as car bodies and high-end consumer products. Even though a CAD system could model Class A curves and surfaces, this does not mean it can provide modeling of functional curves of proper quality according to the criteria of smoothness

C3D Modeler can model top-quality curves and surfaces. It works with Class F curves that meet the following requirements:

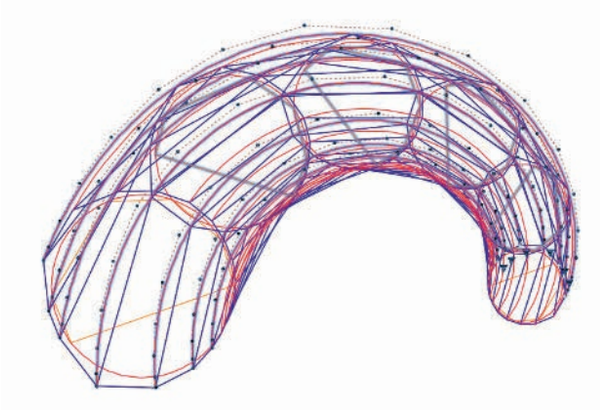
+ the minimal number of reference points of a modeled spline trajectory and a high, not lower than the 4th, order of smoothness;
+ smooth torsion of a spatial curve;
+ limiting the maximal value of the curvature and the rate of its change;
+ minimization of the potential energy functional.

Class F curves are modeled with methods provided by our C3D FairCurveModeler. The methods generate high-quality curves that meet exacting smoothness criteria, and so offer the following advantages:

+ sustainable shape generation(isogeometricity);
+ invariance to affine transformations and projections;
+ the possibility of isogeometric approximation of analytical curves that preserves their basic features;
+ flexible and various API.

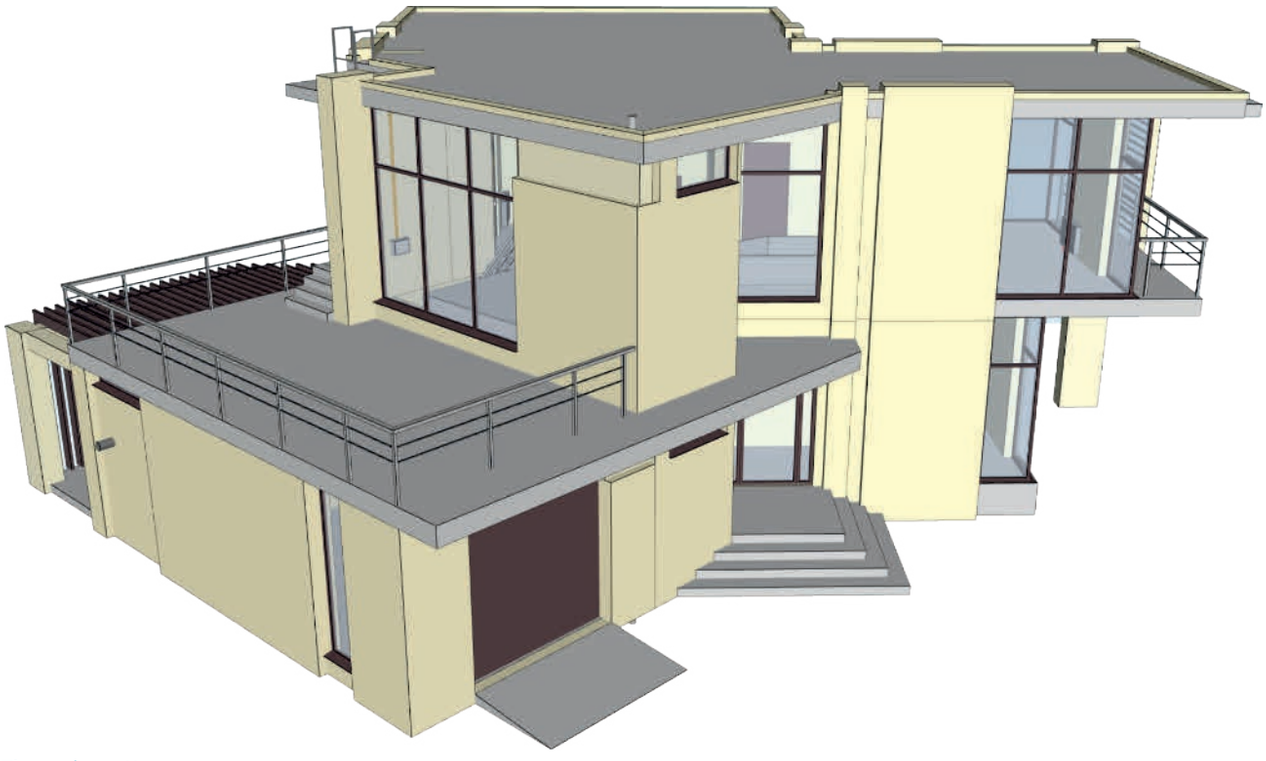


A wireframe of the S-polygons of the B-curve generatrices



A wireframe of the S polygons forms an S-frame of the B-spline surface

C3D Web Vision



The maisonette

Control 3D visualization of your Web application

Benefits:
C3D Web Vision consists of a microservice and a GUI client. Such as architecture gives a boost to web developers: they can accelerate the product development, control visualization capabilities, and load large assemblies without expert skills in 3D graphics. With C3D Web Vision, you can build BIM, AEC, PLM, CAM, and EDA web applications with stunning 3D graphics. The module creates interactive 3D scenes, uses the 3D model tree, offers interactive scene manipulation, and more.

C3D Web Vision offers:

+ 3D model visualization, view management;
+ interactive geometry control.

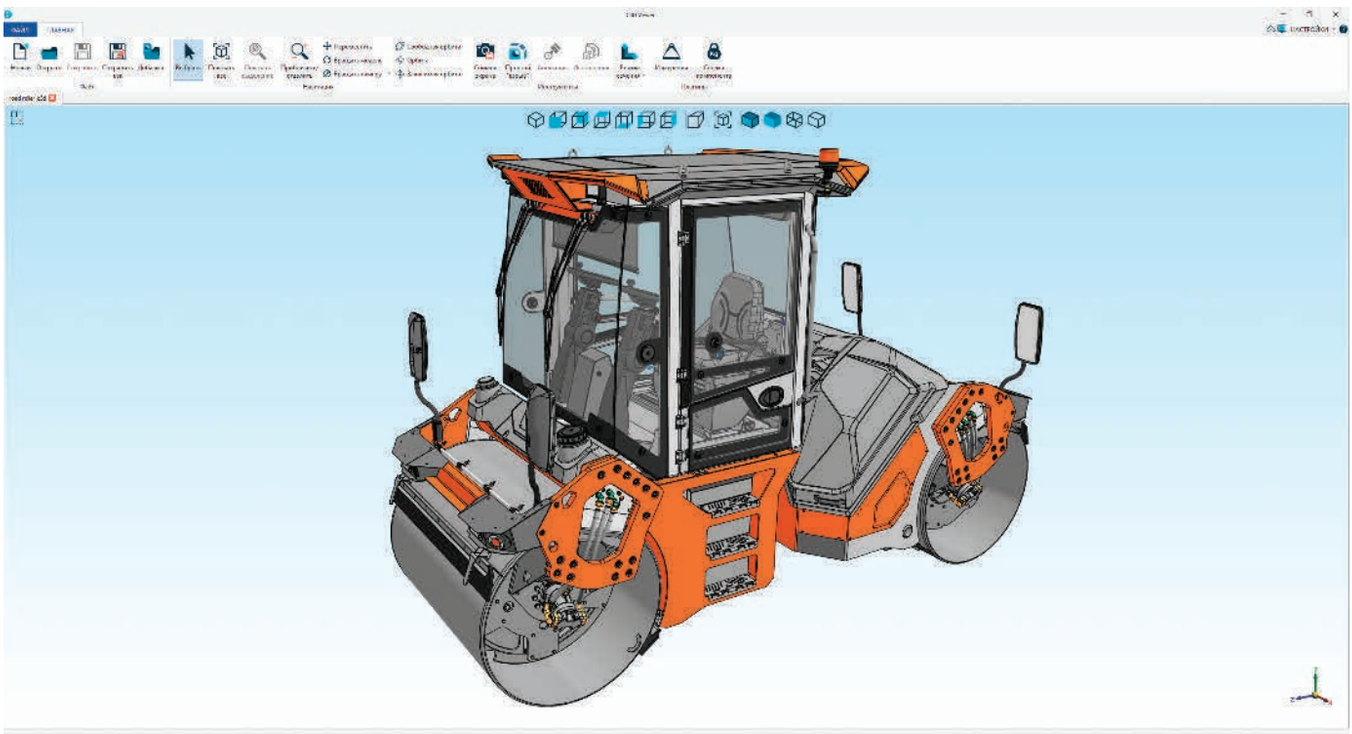
Integrated Environment
C3D Web Vision is closely integrated with our other C3D components:

+ C3D Converter: to read third-party formats;
+ C3D Modeler: to generate triangulation meshes, optimize and fix geometry.

Interactive Model Features
C3D Web Vision can:

+ select geometry under the cursor or in a fence;
+ build cross sections using multiple planes;
+ add annotations, measurements;
+ adjust transparency, visibility, color,
+ hide/show elements.

C3D Viewer



Asphalt roller

C3D Viewer is an easy-to-use application for 3D geometry visualization. It can read models in standard CAD formats and save them in the C3D format. It uses C3D Modeler, C3D Solver, C3D Vision and C3D Converter modules of the C3D Toolkit

Geometry Import and Export:

+ reading C3D, JT, STEP, X_T, X_B, SAT, IGES, STL, VRML, OBJ formats;
+ loading multiple models into one scene;
+ saving models to C3D and as JPEG, TIFF, BMP, PNG images.

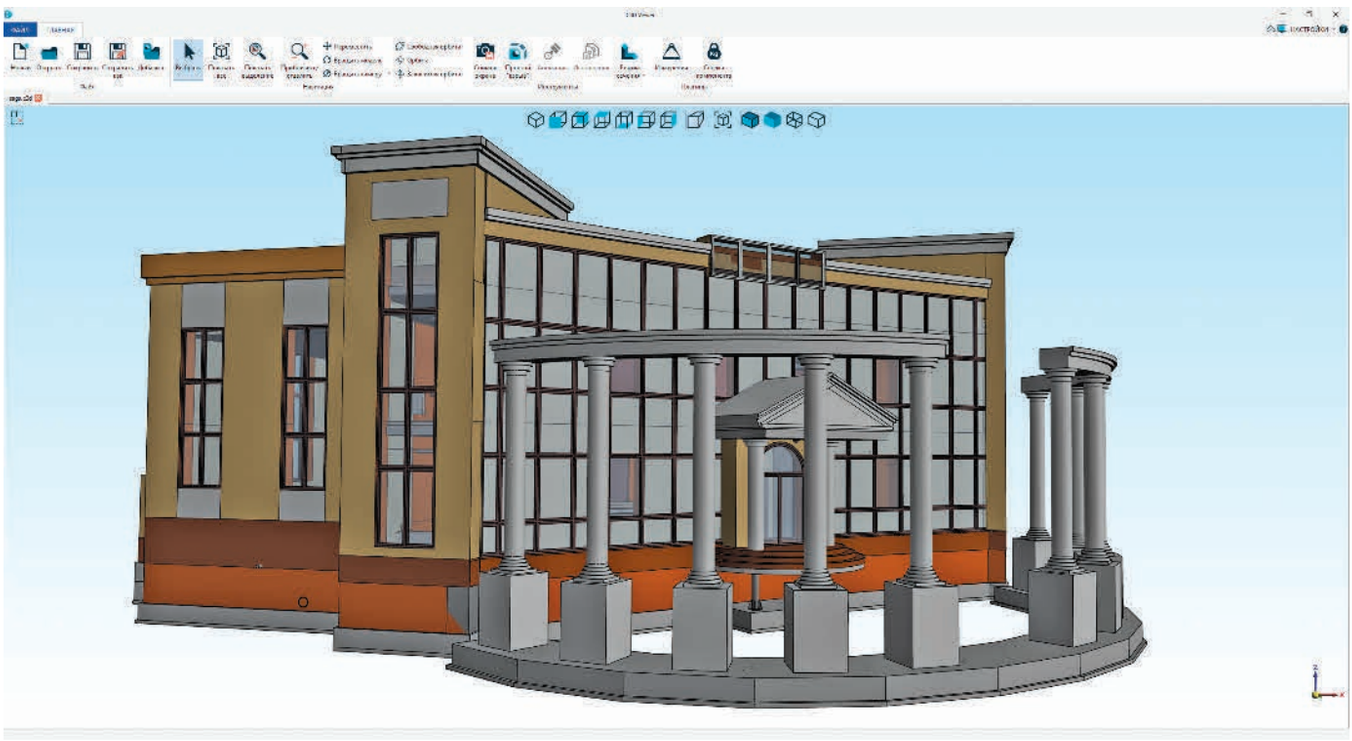
Navigation Functions:

+ pan;
+ rotate the model;
+ rotate the camera;
+ orbit rotate;
+ zoom;
+ standard views.

Model tools:

+ screenshots;
+ exploded views;
+ lighting settings
+ light settings
+ animation (if available);
+ view of multiple model configurations (if available);
+ dynamic cross-sections;
+ geometric measurements;
+ isolation of the selected object;
+ mass, moments of inertiaand other physical properties.

Download
C3D Viewer for free



Marriage Palace

Rendering and Performance Functions:

+ parallel /perspective projections;
+ shaded/ wireframe / hidden line removal modes.

Performance options for better experience with complicated models:

+ hiding edges in the shaded view mode;
+ anti-aliasing;
+ pixel/frustum culling.

C3D Viewer Standard Edition is a stand-alone desktop application:

+ free and unlimited;
+ installation packages for Windows 32/64-bit, Linux;
+ interface languages: English, Russian.

Enterprise edition

C3D Viewer is available as an embedded visualization tool with a simple API. Developers can quickly add C3D Viewer to their products. A license key is required.

C3D Viewer Enterprise Edition offers additional functionality:

+ saving 3D models to JT, STEP, X_T, X_B, SAT, IGES, STL, VRML formats;
+ adding annotations to 3D models;
+ proprietary ActiveX-based API for integration with corporate IT systems.

C3D Labs develops tools for engineering software, including the geometric kernel (SDK), a key software component for 3D CAD.

The company was founded in 2012.

In 2026, more than 60 companies are using C3D software components.

www.c3dlabs.com

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