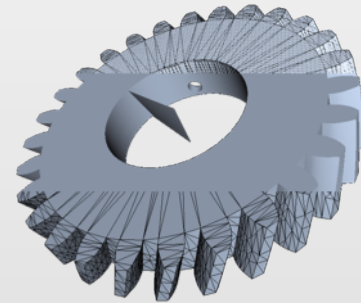


# Low.3D<sup>®</sup>



## The Ultimate 3D Optimization Technology

[www.low3d.com](http://www.low3d.com)

# Low.3D - Introduction

**Developing advanced computer graphics software, including solutions for 3D model optimization, polygon decimation and data visualisation.**

Founded in 2002, based in Markham, ON

First low.3D Desktop product sales - 2003

More than 500 customers, including 300+ business users:

- Automotive, Academia, Aerospace and Defense, Virtual Reality and Training simulators, Media and Publishing, CAD/CAM/CAE, Gas and Oil, GIS/BIM, Architecture, GameDev, Jewelry Design, etc.
- Bechtel (USA), Rio Tinto Pilbara Iron (Australia), University of Rochester (USA), Adidas Group (Germany), Octaga Visual Solutions (Norway), Daimler AG (Germany), General Motors (USA, Canada), BAE Systems (USA, UK), GeoNT Co. Ltd. (Korea), Cristal CG (China), EZD Tech (Spain), Sunglass (USA), many others

Press:



# Low.3D - The Ultimate 3D Optimization Technology

Low.3D speciality is

**high-quality decimation, topology repair and on-line visualization** for large polygonal 3D models (from thousands to billions triangles)

Low.3D offers several polygon reduction and model optimization techniques to deal with highly complex and oversampled 3D meshes:

- **Reducing** the number of polygons up to 100+ times while preserving the visual quality with minimum geometry degradations
- Adaptive mesh **topology repair and optimization**
- Intelligent **high-quality decimation** for models with non-continuous textures and complex visual attributes.
- One step **LOD-chain generation** with the best possible balance between the number of polygons and desired level of details
- Efficient **mesh operations**: boolean, offsets, intersections



# Low.3D - The Ultimate Benefits:

## The Ultimate 3D Optimization to save TIME and MONEY while increasing QUALITY:

### High Quality Decimation - polygon count reduction

*similar to lossy compression: MP3 for music, JPEG for images*

- Simplifies models to reduce computation and visualization times
- Reduces model sizes to mitigate storage and bandwidth requirements
- Improves export quality for polygonal formats (STL, OBJ, PLY, GLTF, etc)

### Instant LOD-chains – multi-resolution representations with best possible balance between model size and level of details

- Reduces computation time by one step generation
- Instant any-level LOD retrieval without addition computations
- Multi-resolution streaming ready for on-line visualization

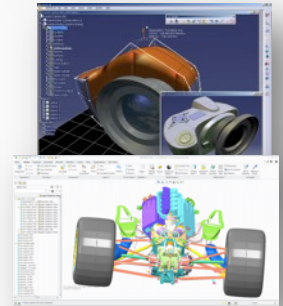
### Model topology enhancements and geometry repairs – fixing mesh defects and enhancing topology features for Reality Capture models

- Fixes mesh defects for 3D scans and photogrammetry
- Restoring straight edges and plane surfaces for photogrammetry models
- Converting non-manifold topology
- Boolean mesh operations, offsets, intersections and waterproofing

# Low.3D - The Ultimate Solutions

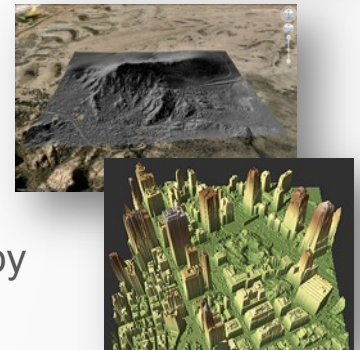
## For 3D Design, CAD/CAM, AEC and Additive Manufacturing:

- Generate and optimize models for on-line 3D visualization, 3D printing and VR/AR applications
- Optimize internal tessellation to decrease model size and reduce processing times in 50-200%
- Produce high quality 3D thumbnails and preview images
- View and interact with imported polygonal models in real time



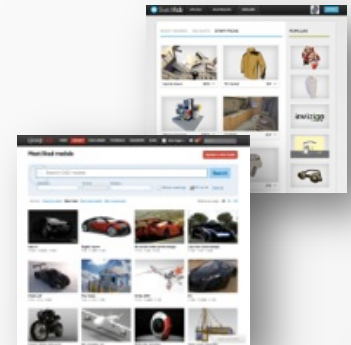
## For 3D Capture, Photogrammetry and Spatial Data Processing (GIS/BIM):

- Produce high-quality mesh from raw point cloud data
- Repair topology, fix mesh defects and reduce irregular models produced by OEM tools
- Optimize 3D-scan models to produce high-quality LOD in real time
- Increase visualization speed and add interactivity to web applications



## For on-line 3D visualization, Virtual/Augmented Reality, cloud-based PLM and on-line 3D model marketplaces:

- Improve user experience by enhancing visual quality and reducing download time
- Create instant LOD-chains for specific presentation conditions
- Save money by reducing storage, bandwidth and memory requirements



# Low.3D - Products and Services

**low.3D SDK** - a drop-in OEM solution to incorporate advanced 3D optimization and polygon decimation technology into existing or new 3<sup>rd</sup>-party applications

- Rich and straightforward C++ API
- Scalable 64-bit architecture to support models with up to 3B triangles
- Robust performance and application controlled memory footprint
- Domain-specific optimization profiles and custom plugins



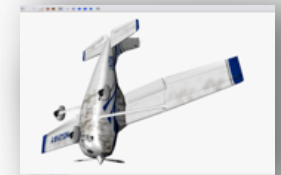
**low.3D Desktop** – a complete 3D model optimization solution at your desktop

- Built-in 3D viewer for visual control during model optimization
- Batch mode reduction and optimization
- Supports OBJ, GLTF and STL file formats



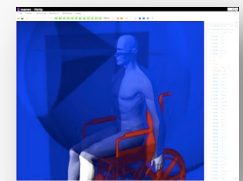
**low.3D Web** – SaaS solution for 3D model optimization

- Cloud based, platform independent
- Delegates CPU and memory extensive computations into the cloud
- RESTful web-service API for integrations with 3<sup>rd</sup> party applications
- WebGL 3D visualization



**low.3D Custom Solutions and Services:**

- Custom 3D solutions for CAD/CAM, Virtual/Augmented Reality, 3D-Capture and Geo-Spatial Data Processing, Architecture, Civil Engineering and Medical Applications
- Engineering graphic libraries and viewers

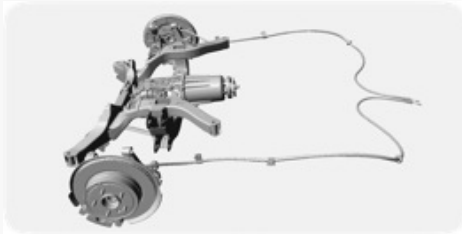


# Low.3D - The Ultimate 3D Optimization Technology

low.3D Technology addresses challenges of working with large and complex 3D models:

## COMPLEXITY

Models are unnecessarily complex or oversampled



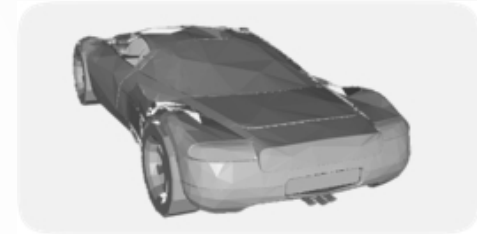
## RESOURCES

Immense bandwidth and storage requirements



## VISUALIZATION

Inferior visual quality  
Long rendering times



low.3D Technology provides the advanced solutions:

**HIGH QUALITY  
POLYGON REDUCTION  
AND OPTIMIZATION**  
to reduce complexity,  
decrease model size and  
repair topology

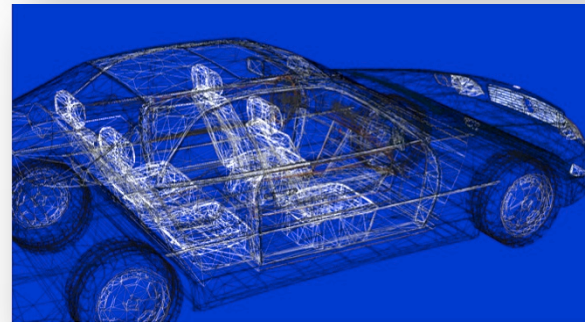
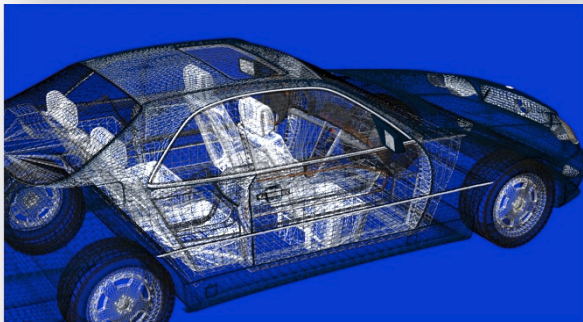
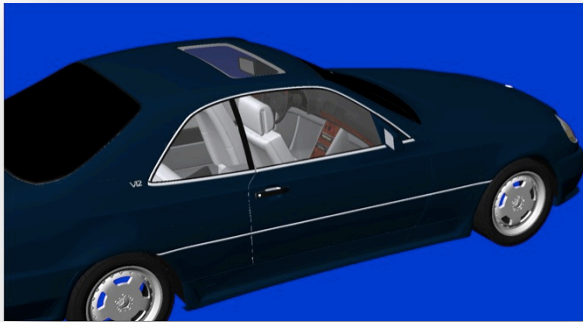
**INSTANT LOD-CHAIN  
GENERATION**  
to increase visualization  
speed and reduce resource  
consumption

**EXQUISITE  
VISUALIZATION**  
to control optimization  
and present your work

# Low.3D - Technology - Polygon Decimation

High Quality Polygon Decimation - the best possible balance between the model size and desired level of detail:

- reduces number of polygons up to 100 times while keeping the visual quality
- increases rendering performance and reduces models size
- decimates millions of polygons in seconds with low memory footprint
- intelligent handling of shape boundaries and visual attributes

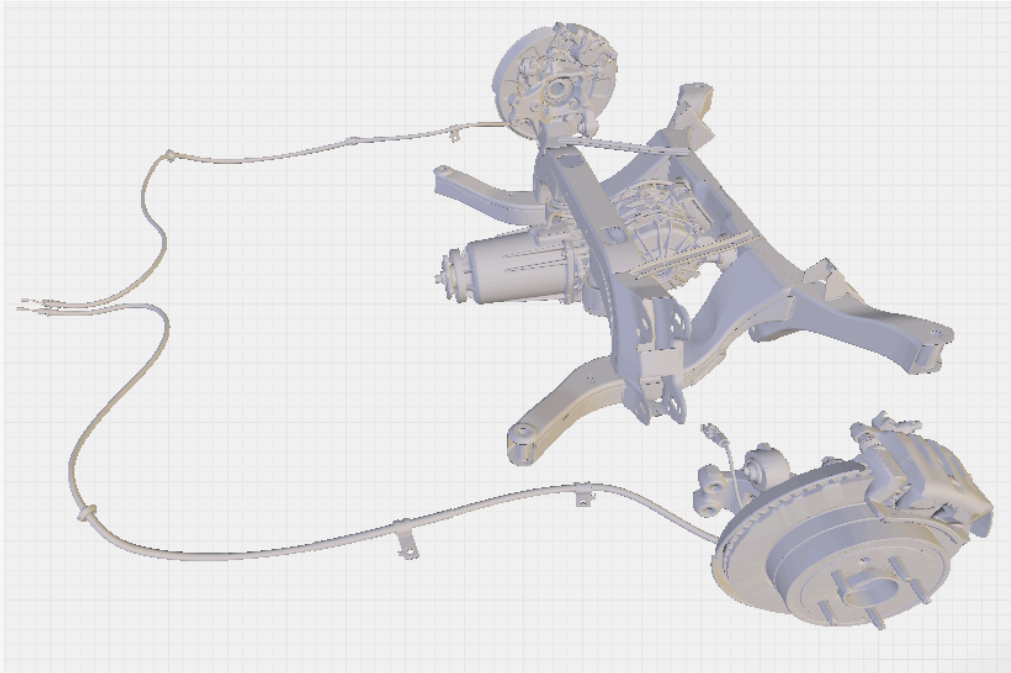


90% reduction - 28,204 triangles vs 282,047 in the original model



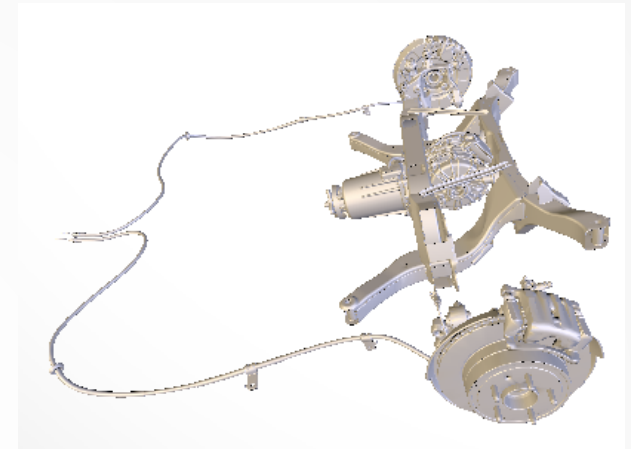
# Low.3D - Technology - Polygon Decimation

(example) CAMI (GM) Assembly



Original model 2,249,649 triangles (144MB)

Interactive 3D Views:  
<https://www.low3d.com/low.3d-solutions.html>



Optimized model, 75% reduction  
562,411 triangles (41MB)



Optimized model, 90% reduction  
224,963 triangles (15.5MB)

# Low.3D - Technology - Instant LOD generation

## Instant LOD (Level of Detail) generation:

- The best possible balance between the number of triangles and required level of details
- One-step simultaneous computation for a complete LOD-chain
- Dynamic selection of decimation ratio in real-time



Design View



Original part  
51282 triangles

Preview  
Single Part



97% reduction  
1538 triangles

Preview  
Sub Assembly



98%  
1024 trs

Preview  
Assembly



99%  
512 trs

# Low.3D - Technology - Instant LOD generation (example)

Instant LOD (Level of Detail) generation:

- Original model: 1M triangles
- LOD-chain: 90% - 99.99%

Interactive 3D view:

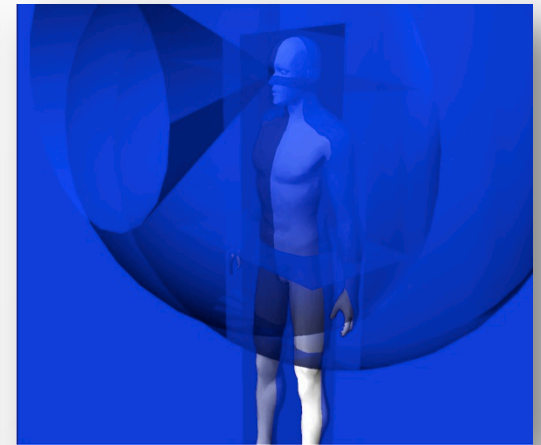
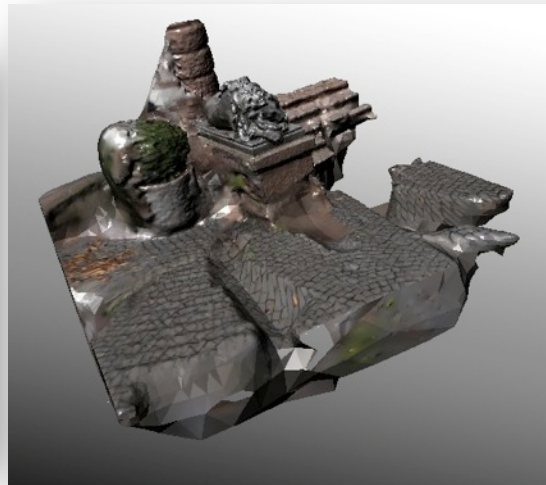
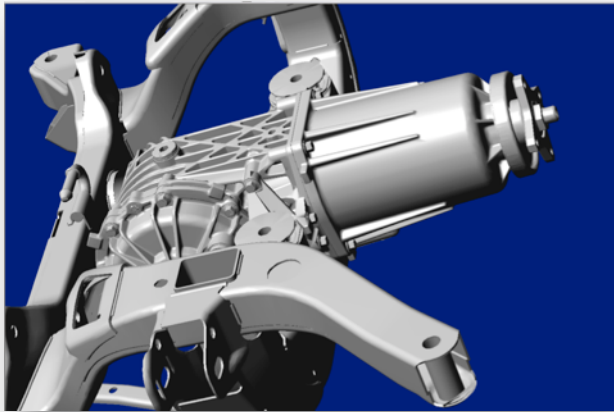
<https://www.low3d.com/low.3d-solutions.html>



# Low.3D - Technology - 3D Optimization

Adaptive 3D model optimization for mesh repairs and quality improvements:

- Merges adjoining shapes or shapes with same material.
- Recalculates and refines normals.
- Repairs and heals irregular meshes by removing overlaps, closing gaps and fixing intercrossings.
- Custom optimization profiles for CAD/CAM, 3D scanners and LiDARs, Architecture, 3D Printing, Virtual and Augmented Reality, etc.



# Low.3D - Technology and Products Updates (Spring 2020)

## New 64-bit SDK version – supports models over 1B triangles

- Reduced memory consumption (200MT - 16MB)
- Application controlled memory footprint
- “Lean optimization” mode for extra-large models (>1B)
- Linux port (Ubuntu 20.04)

## Dynamic and static LOD:

- Produce “instant” LOD on demand with any ratio in real-time
- Generate a multi-resolution LOD-chains in one step
- 3D lossy and lossless data compression for fast download

## Advanced optimization for complex models:

- Support for non-manifold geometry
- Progressive bulk regeneration for normals
- Support for non-continuous textures

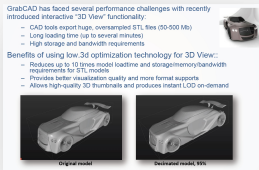
## Mesh topology and geometry repairs:

- Removing gaps and overlaps
- Fixing duplicated and intercrossing triangles
- Making “water-tight” mesh

## Point Cloud data processing (in works):

- Point Cloud triangulation for raw 3D scanner and LiDAR data
- Smart optimization based on raw point cloud data
- Split and Merge technology for XXXL models

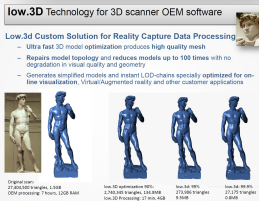
# Low.3D - Recent Customer Case Studies:



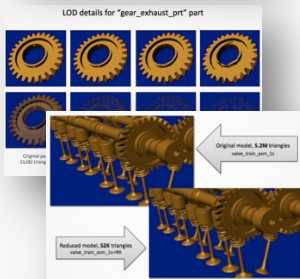
- **Sunglass.io and GrabCAD** – Using low.3D technology to increase usability of 3D view functionality



- **Mammoth Cave LiDAR**- using low.3D technology to repair and optimize LiDAR data for National Park Service and Cave Research Foundation



- **Artec 3D** – integrating low.3D Technology to improve 3D scanner OEM software



- **PTC** – Using low.3D technology to optimize CATIA CGRs files for Creo 2.0 heterogeneous assemblies and generating high quality preview images and thumbnails



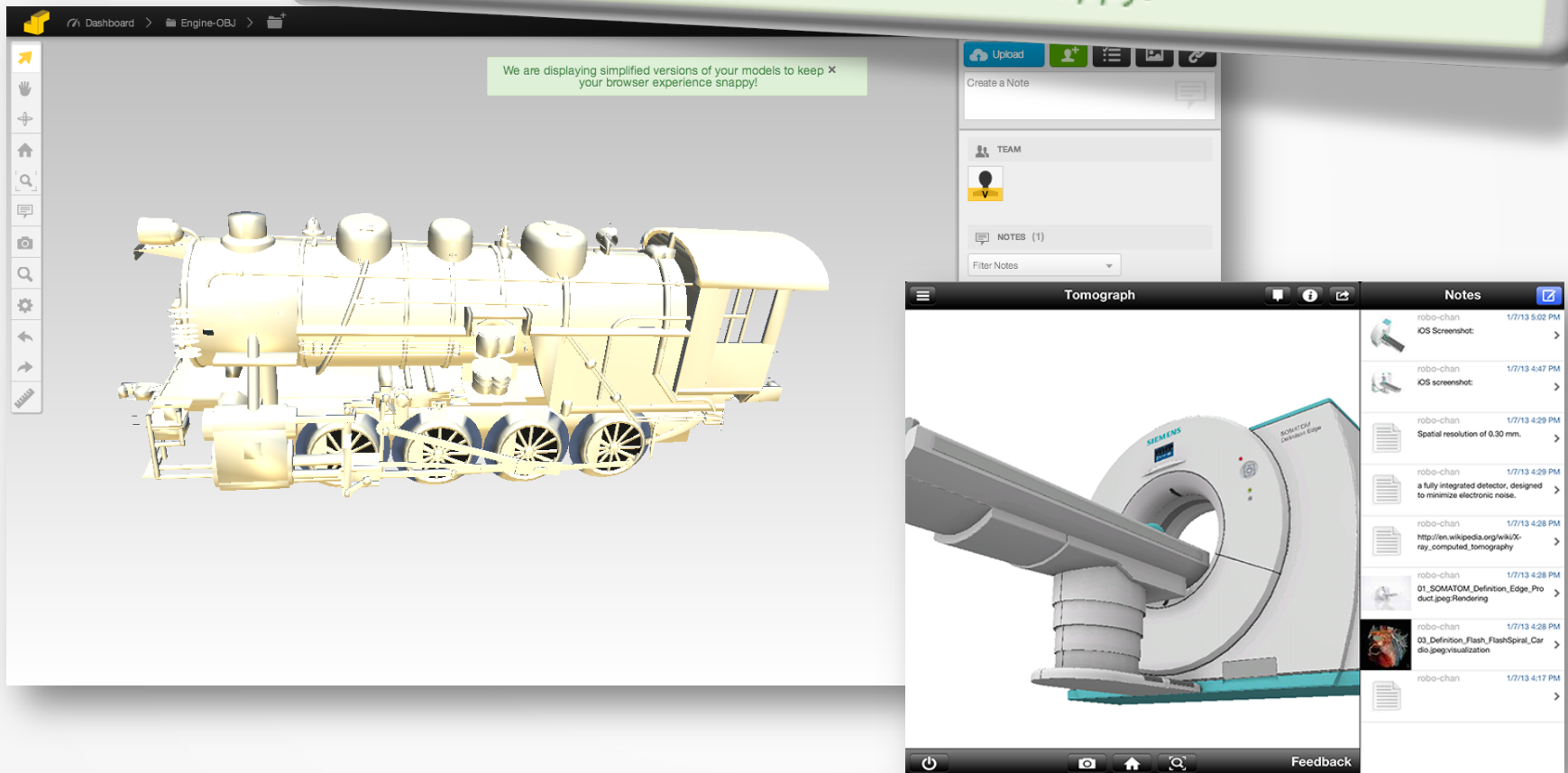
- **SketchFab** - Using low.3D technology to generate low resolution models to reduce storage and bandwidth requirements

# low.3D Technology in Sunglass.io



[Sunglass.io](https://www.sunglass.io) uses low.3D 3D model optimization for on-line visualization and mobile applications:

*We are displaying simplified versions of your models to keep x your browser experience snappy!*



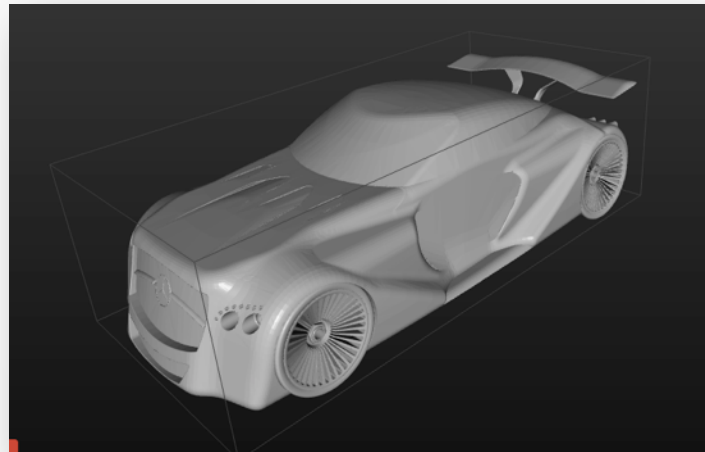
GrabCAD has faced several performance challenges with recently introduced interactive “3D View” functionality:

- CAD tools export huge, oversampled STL files (50-500 Mb)
- Long loading time (up to several minutes)
- High storage and bandwidth requirements

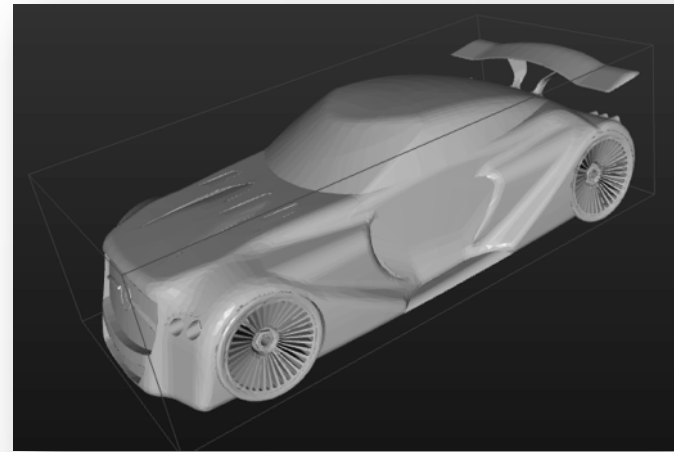


Benefits of using low.3D optimization technology for 3D View::

- Reduces up to 10 times model loadtime and storage/memory/bandwidth requirements for STL models
- Provides better visualization quality and more format supports
- Allows high-quality 3D thumbnails and produces instant LOD on-demand



**Original model**



**Decimated model, 95%**

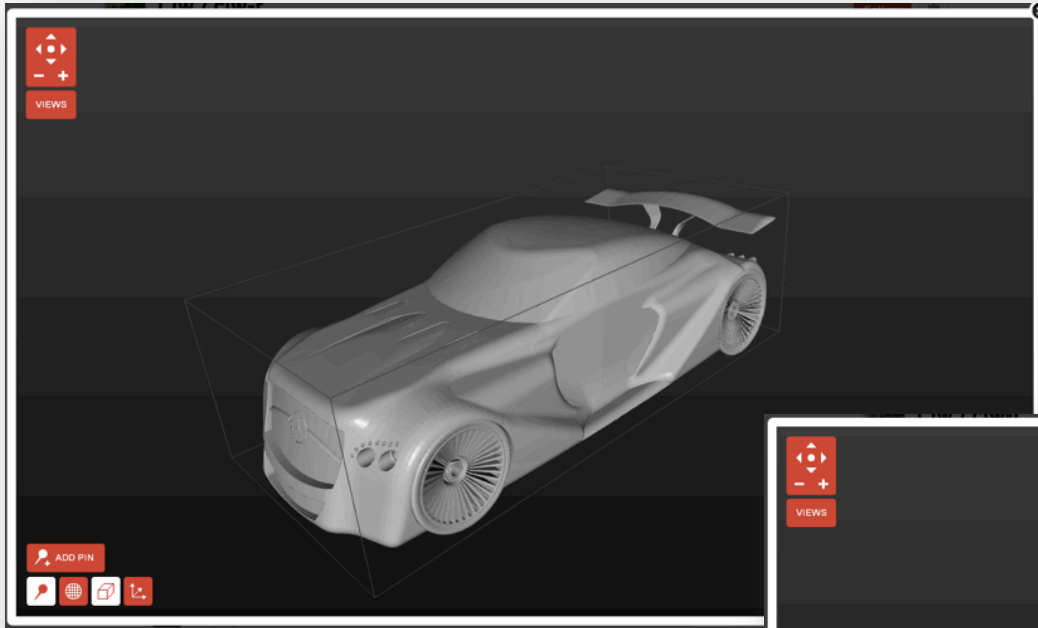


# low.3D Technology for GrabCAD - 3D View case studies



## Original model:

- 535,704 triangles
- Size: **26Mb**
- Loading time: **20 – 200 sec**



## Decimated model, 95%:

- 26,784 triangles
- Size: **1.3 Mb**
- Loading time: **5 - 12 sec**



<http://grabcad.com/library/clw-clw-r>

# low.3D Technology for LiDAR data optimization



Cave Research Foundation (CRF) and Washington University in St. Louis (WUSTL) performed a ground-breaking LiDAR scan of Mammoth Cave four miles trail in central Kentucky, USA

A data summary of the project:

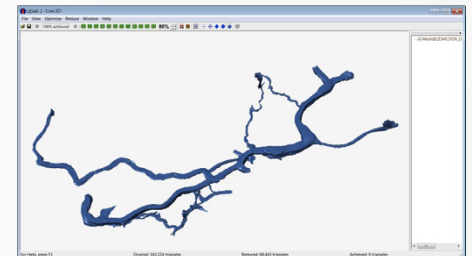
- Over 18 million data points collected.
- Over 15 million triangles used to create surfaces.

*“The ability to collect massive point data sets appears to be well beyond the ability to do anything meaningful with the data back at the office.”*

Aaron Addison, GIS Coordinator from WUSTL

**Low.3D** teamed up with **WUSTL** to face the challenge:

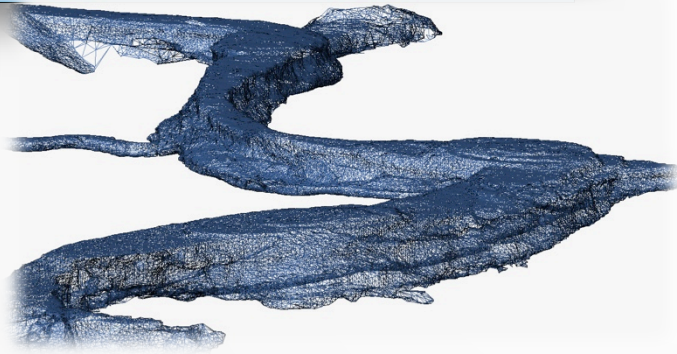
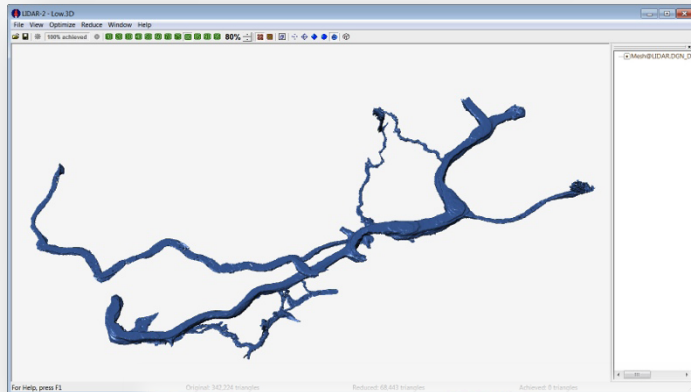
- Original irregular TIN produced from LiDAR data was repaired and optimized by **low.3D custom GSDP solution** to remove overlapped and intercrossing triangles
- The optimized mesh was further reduced by 90% with **low.3D SDK** to be suitable for the animation software



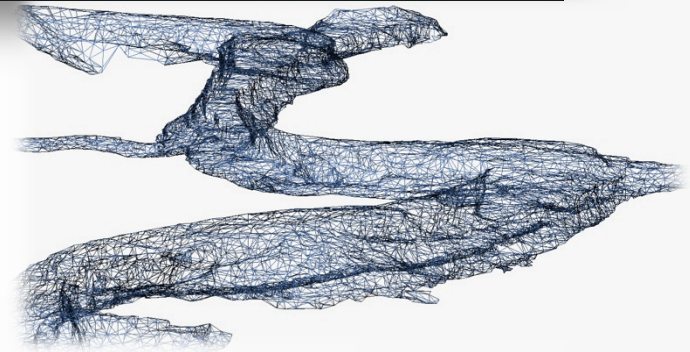
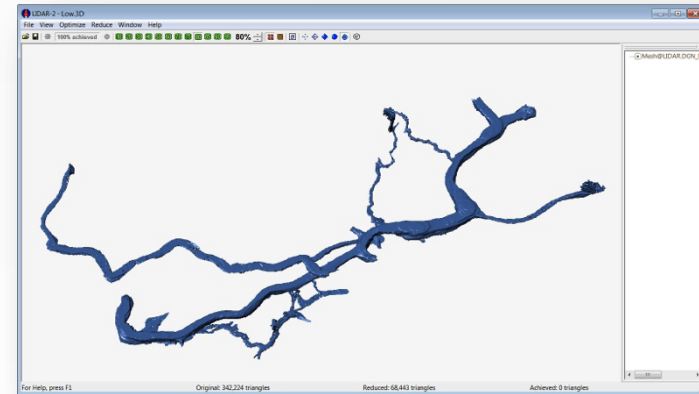
# low.3D Technology for LiDAR data optimization



Mammoth Cave LiDAR data repaired and optimized by low.3D 3D model optimization tools:



Original mesh - 684,448 triangles,68MB



low.3D optimized mesh – 68,443 triangles,4.6MB

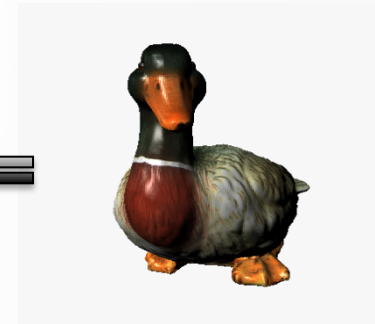
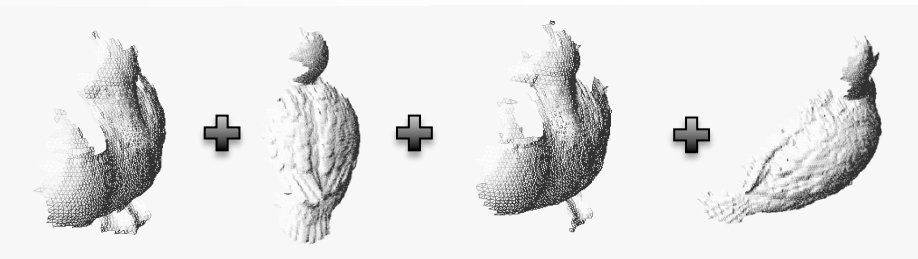
Click on the images to view and compare the optimization results in 3D

# low.3D Technology for 3D scanner OEM software



## Typical problems with 3D scanner OEM software:

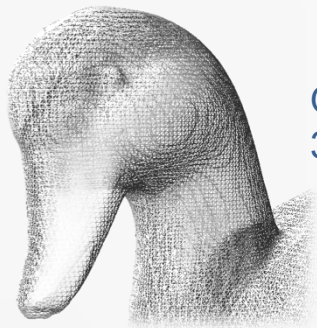
- Takes hours to process scanned data to generate 3D models
- Produces oversampled, **low quality mesh**
- Creates **irregular model topology** (with gaps, overlaps, duplications)
- Generated 3D models are **too heavy for visualization** and for **import** into 3<sup>rd</sup> party software products.
- Uses generic polygon-reducing algorithms that produce **non-optimized, inferior 3D models**



## An example from 3D scanner (0.5mm resolution)

Original scan: **206,650 triangles, 18.3MB**

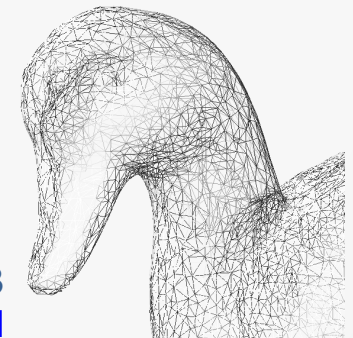
3D View: <http://skfb.ly/k4ji2f10ba>



low.3D optimized model (80% reduction)

**41,330 triangles, 2.4MB**

3D view: <http://skfb.ly/k4ji2f1d>



# low.3D Technology for 3D scanner OEM software



## Low.3D Custom Solution for Reality Capture Data Processing

- Ultra fast 3D model optimization produces high quality mesh
- Repairs model topology and reduces models up to 100 times with no degradation in visual quality and geometry
- Generates simplified models and instant LOD-chains specially optimized for on-line visualization, Virtual/Augmented reality and other customer applications



Original scan:

27,404,500 triangles, 1.5GB

OEM processing: 7 hours, 12GB RAM



low.3D optimization 90%:

2,740,345 triangles, 134.8MB

low.3D Processing: 17 min, 4GB



low.3D: 99%

273,986

triangles 9.5MB



low.3D: 99.9%

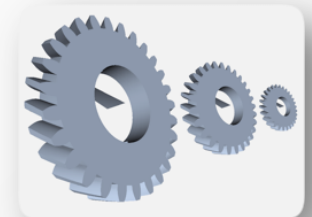
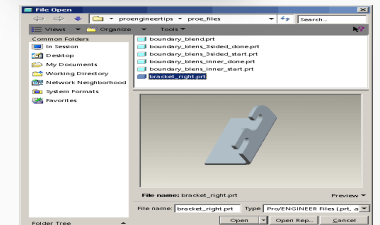
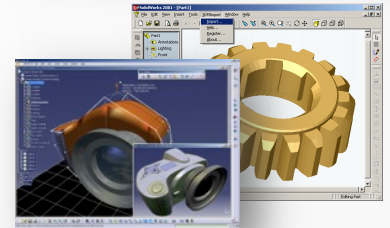
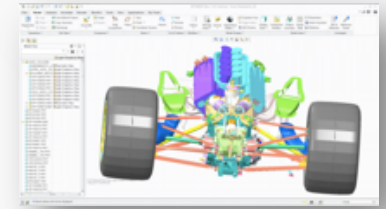
27,175

triangles 0.8MB



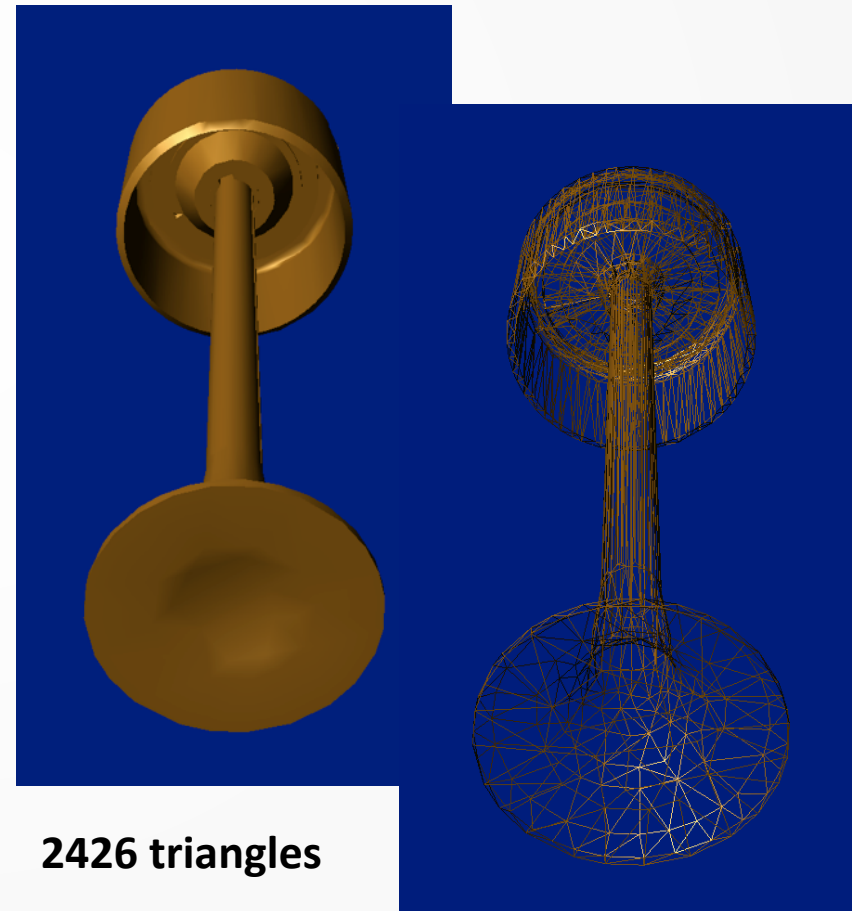
## Benefits of using low.3D advanced 3D model optimization and high quality decimation in PTC products:

- Optimize internal geometry tessellation to reduce model size and decrease part retrieval time
- Decimate 3D party CAD models for run-time visualization in Creo 2.0 heterogeneous assemblies.
- Produce high quality 3D thumbnails for Windchill CAD Document pages and Model Preview images for File->Open dialogs in Creo
- Exploit Instant-LOD technology for CAD model comparison, 3D search and shape recognition

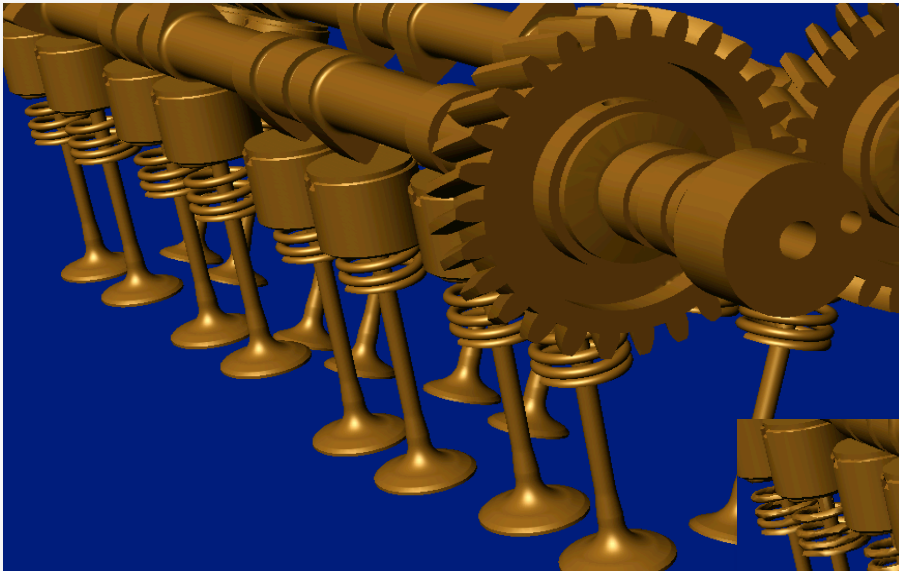


low.3D optimization for CAD models – 90% reduction

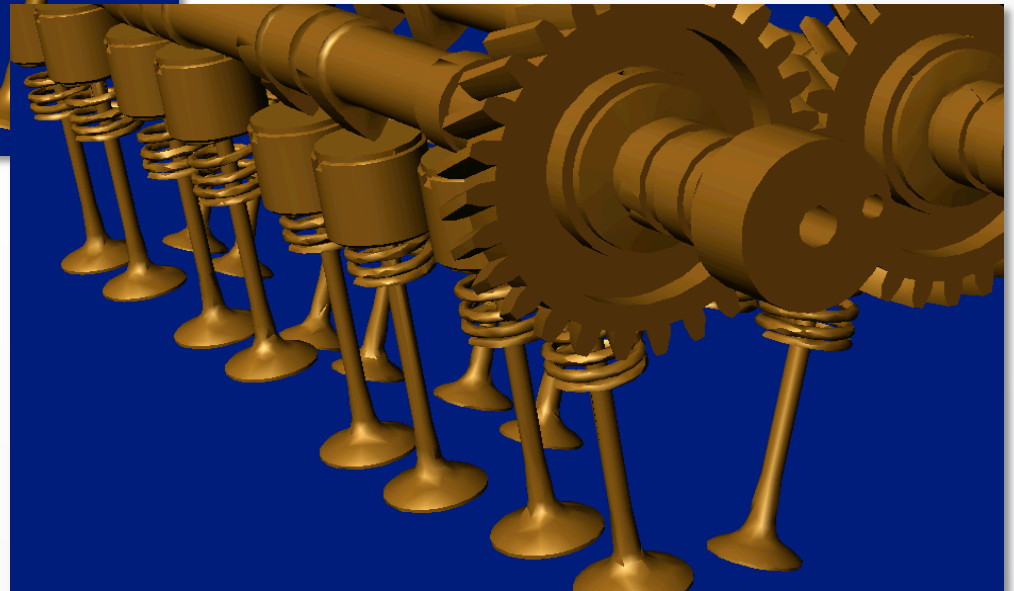
- 10 times less nodes and triangles
- 10 times less memory and disk space



CATIA CGR assembly low.3D optimized for run-time visualization in Creo 2.0 heterogeneous assembly.



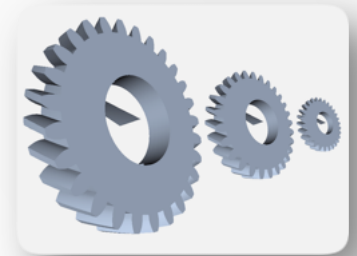
Original model,  
**5.2M** triangles



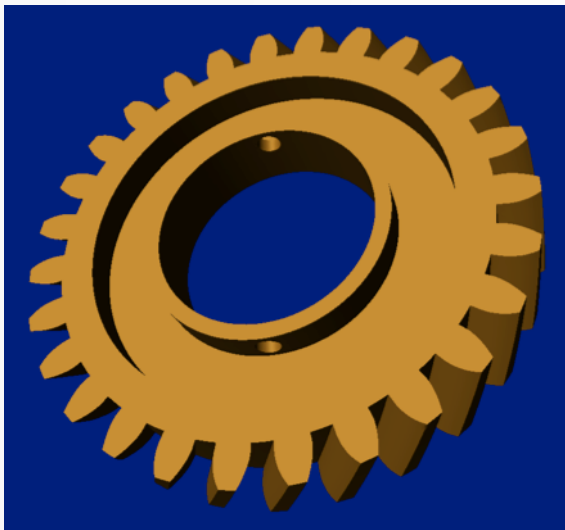
Reduced model,  
**52K** triangles



## Sample LOD-chain for Creo File->Open Preview



Design View:  
Single Part



Original part  
51,282 triangles

Preview  
Single Part



97% reduction  
1,538 triangles

Preview  
Sub Assembly



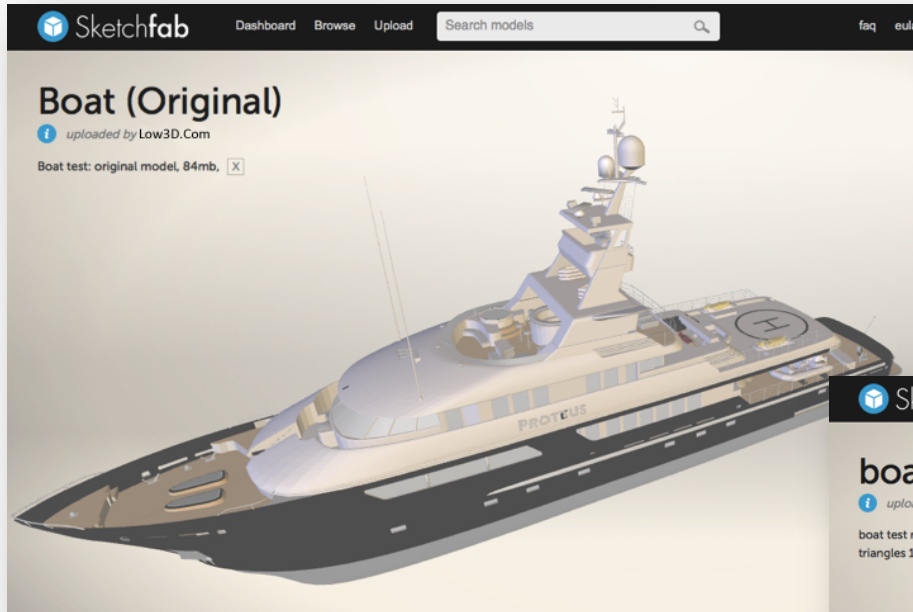
98%  
1,024 trs

Preview  
Assembly



99%  
512 trs

Using low.3D technology to generate low resolution models to reduce storage and bandwidth requirements



## Original model:

- 759,491 triangles
- Size: **40 Mb**
- Loading time: **45 sec**

<http://skfb.ly/4ihfe1cba>



## Decimated model, 80%:

- 159,097 triangles
- Size: **8 Mb**
- Loading time: **12 sec**

<http://skfb.ly/4ihfe1c0ba>

# Low.3D - Thank you!

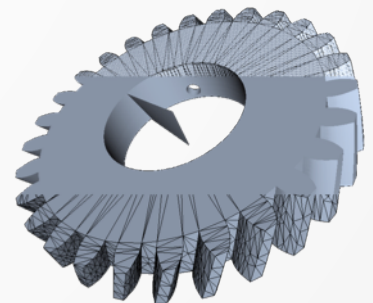
## Contacts:

Email: [sales@low3d.com](mailto:sales@low3d.com)

Web: [www.low3d.com](http://www.low3d.com)

LinkedIn: [low3d](#)

Phone: (617) 500-3103



# Low.3D - Technology Partners

## 3D model import/export:

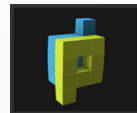


Mesh export from native CAD formats

3D format conversions

Multi-platform Development toolkits

## Online 3D content and vizualization:



CAD/CAM, 3D Design, Virtual/Augmented Reality, GameDev model stores and archives

WebGL and PDF 3D on-line visualization

Engineering, designer and artistic communities

# low.3D SDK - Technical specification

## System:

- Thread safe, 64-bit architecture
- No external dependencies
- Application controlled memory usage

## Platforms:

- Windows 32-bit and 64-bit
- Linux 64-bit: Ubuntu 20.04
- MacOS: 10.7/10.8 - custom ports

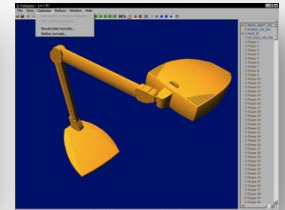
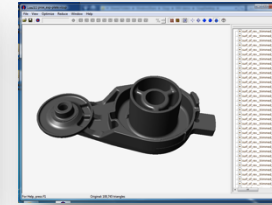
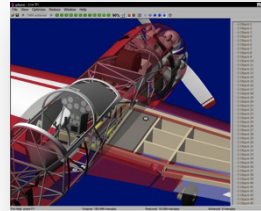
## Functionality and Performance:

- Rich C++ API, Open GL style
- Straghtforward “load->optimize->retrieve” workflow
- Internal data structures optimized for maximum performance with minimal memory footprint
  - 80B/triangle, 100B with texture
  - 16GB for 200Mt, ~2 hours (i7 Linux x64)
  - up to 3-4Bt w/o swap
- One-step LOD-chains generation
- “Lean optimization” mode for extra-large models (>1B)

# Low.3D - Product Demos

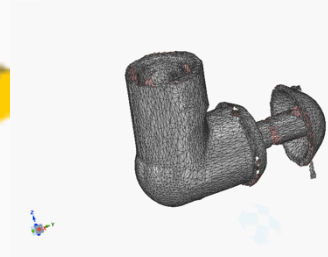
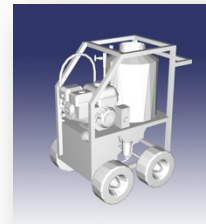
## low.3D Desktop

- Complex GLTF (Plane), 186Kt
- Pro/E GLTF export part,
- Simple GLTF (Lamp), 1.9Kt



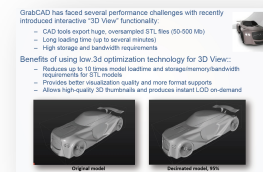
## low.3D SDK:

- Simple App (Pressure Washer)
- [Sunglass.io](http://Sunglass.io)
- SpaceClaim – [reverse engineering](#)



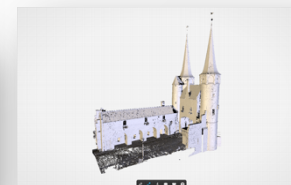
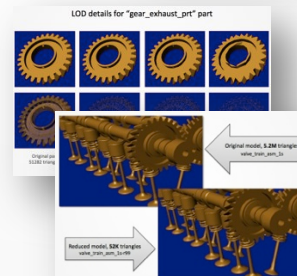
## low.3D Web:

- [GrabCAD](#) collaboration
- [SketchFab](#) examples



## low.3D Custom Solutions:

- PTC
- Autodesk
- DreamingMethods - [Zone](#)



# Low.3D - Autodesk, Reality Capture Group

## low.3D Optimization Results:

Castle: Original model: 27Mt, 2.56GB

### low.3D optimization to 90%, 2.8Mt

- Time 20 min,
- RAM 2.24GB (3.75GB LOD-chain)
- Size: 224MB (138MB STL)

### low.3D optimization to 99%, 0.3Mt

- Size: 22.2MB (13.9MB STL)

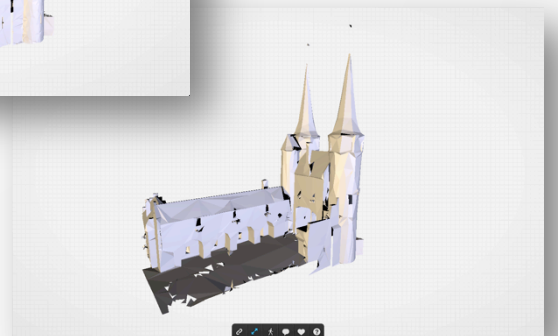
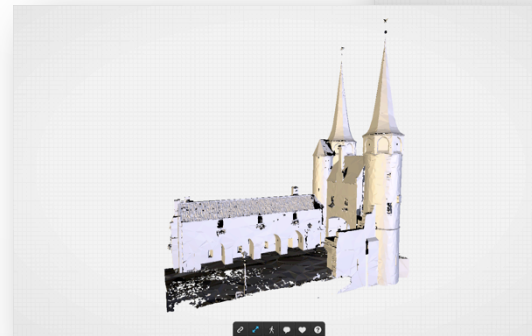
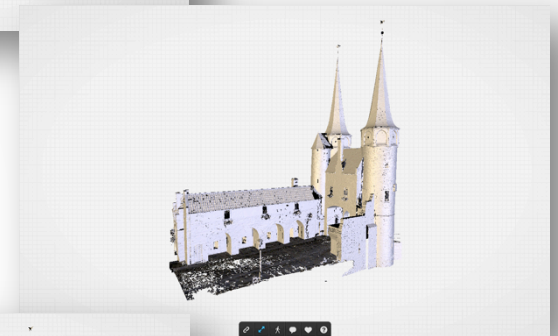
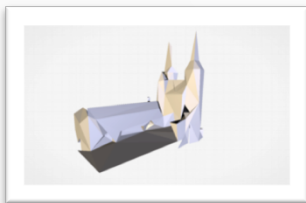
### low.3D optimization to 99.9%, 2.7Kt

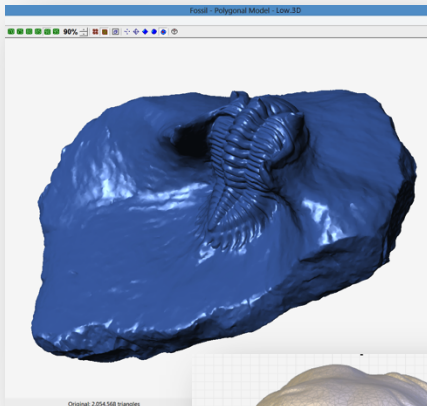
- Size: 2.2MB (1.4MB STL)

### low.3D optimization to 99.99%, 0.3Mt

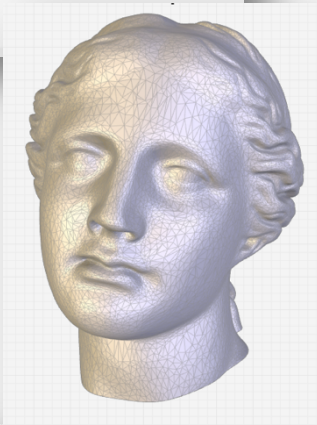
- Size: 199KB (136KB STL)

low.3D optimization to 99.999%, 269t

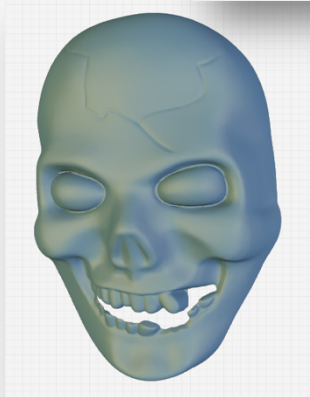




- **Trilobite Fossil**, 90% decimation for 3D scan model



- **Sculpture Head** – low.3D optimization for on-line viewing, 5 and 10 times reductions



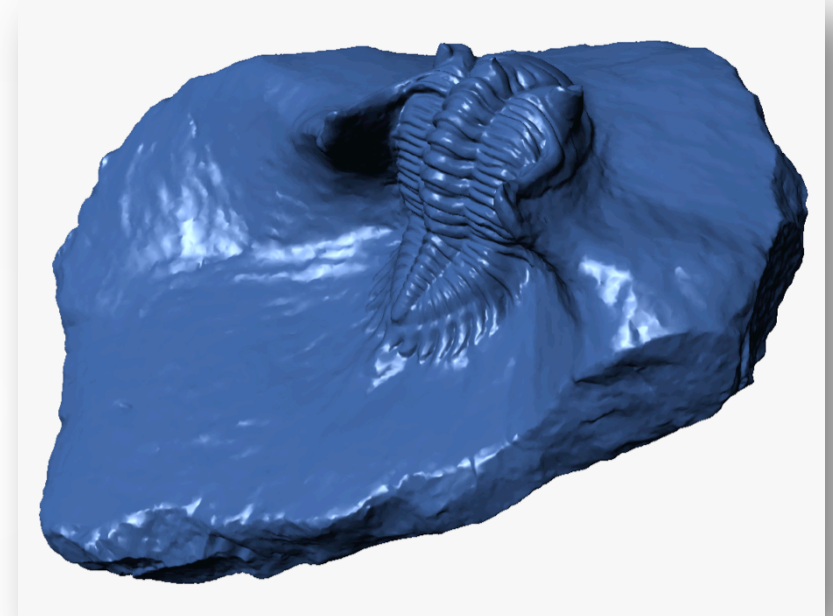
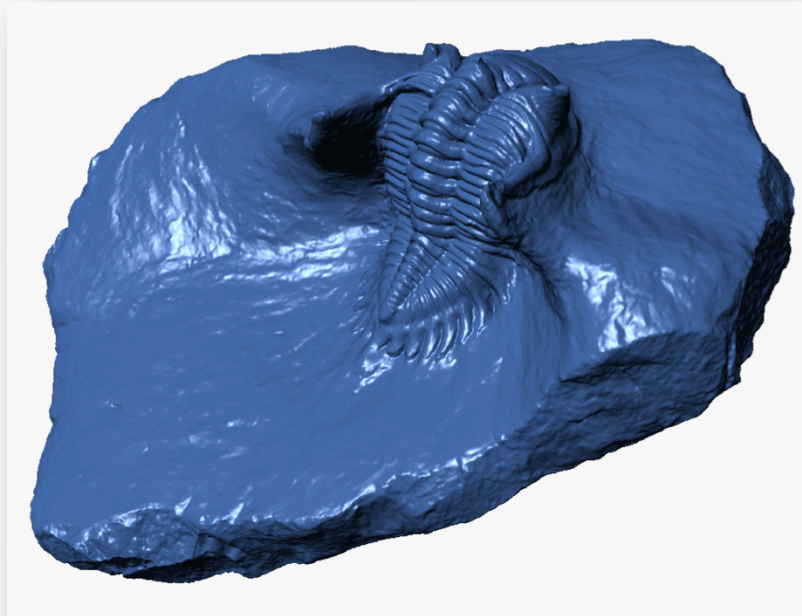
- **Skull Mask** – Compare original low-res model with low.3D 95% reduction of high-res model.



# Direct Dimensions examples - Trilobite Fossil



Compare the original and 10 times reduced models, note almost no visual difference



## Original model:

- 2,055K triangles
- 103MB

## low.3D optimized, 90% reduction:

- 205K triangles
- 10.3MB

See the reduced model in Interactive 3D view: <http://skfb.ly/lk4ih2ed0b>

# Direct Dimensions examples - Head Sculpture

low.3D optimization for on-line visualization - compare the original, 5 and 10 times reduced models, note almost no visual difference



## Original model:

- 535K triangles
- 26 MB



## 80% reduction:

- 107K triangles
- 5.2 MB



## 90% reduction:

- 53.5K triangles
- 2.6 MB

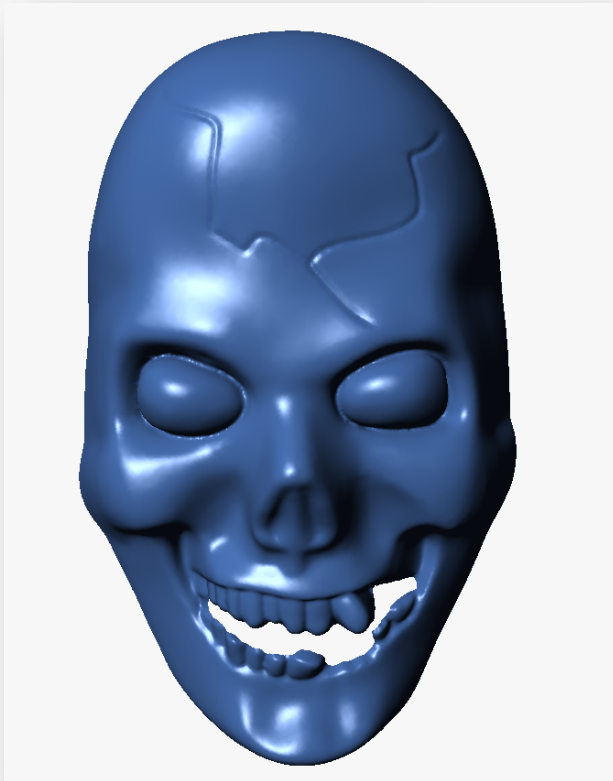
See the reduced models in Interactive 3D view:

80% - <http://skfb.ly/lk4ih2e1cb> , 90% - <http://skfb.ly/lk4ih2e1d0>

# Direct Dimensions examples - Skull Mask



Compare the original low-resolution model and low.3D 95% reduced high-res model



**Original low-res model:**

- 100K triangles
- 7.6 MB



**low.3D optimized, 90% reduction:**

- 33.3K triangles
- 2.3 MB

See the reduced model in Interactive 3D view: <http://skfb.ly/lk4ih2f0a>