

# Data Exchange Best Practices

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Chief Technology Officer  
Kubotek Kosmos

## GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2023



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## Presenters Bio

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### Ram Eswaran

- Chief Technology Officer, Kubotek Kosmos (Marlborough, MA)
- 25 Years in the CAD/CAM software industry
- Areas of Expertise
  - CAD
  - Geometry Kernel
  - File Translators
- Kubotek representative at LOTAR International workshops
- PDES Board, PDES TAC, MBx-IF Implementor Group (STEP AP242)
- MS, BS Mechanical Engineering
- Contact: [reswaran@KubotekKosmos.com](mailto:reswaran@KubotekKosmos.com)

# Kubotek Kosmos Product Lines

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## ➤ 3D Framework (Engineering Software Development Framework)

- ❖ Specialized Applications in CAD/CAM/CAE/Quality/Metrology
  - ✓ Independent Software Vendors
  - ✓ In-house IT Teams
  - ✓ Software Contractors

## ➤ CAD Utility Programs (3D Framework Foundation)

- ❖ Manufacturing Supply Chain
- ❖ Data Migration
- ❖ Data Exchange
- ❖ Products
  - Validate: CAD Model Translation Validation
  - Revision: Engineering Change Detection & Documentation
  - View / Convert: CAD File Viewing, Measurement & Conversion

## ➤ KeyCreator (CAD)

### Target Audience

- ❖ Manufacturing Organizations (Contract Manufacturers, Mold Design, Tooling Shops, ...)
- ❖ Product/Concept Design



# Notable Kubotek Kosmos Customers

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## Kubotek Software Customers



# Data Exchange = Translation

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- Data Exchange = Translation. Embrace it!

- What is involved?

- File Format



- [Binary Data](#)

- Decryption



- File Compression

- Platform Architecture

- [Geometry \(Shape of entities\)](#)

- Understanding of similarities and differences between source system and target system

- [Topology \(How are entities connected\)](#)

- Understanding of similarities and differences between source system and target system

- Assembly Structure, PMI, Lightweight Data, Metadata, etc.

- Access to Database (Cloud software)

- Requires

- Permissions

- API expertise

.xmt .sat .3dm .dae .prt .wrl .igs  
.ifc .jt .iges .step .x3d .sld\*  
.dwg .cat\* .3mf .gltf .dxf  
.iam .psm .xcgm .asm .obj .brep  
.stl .ipt .par .x\_t .fbx



## File Translation Scenarios

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- LOTAR (Long term archiving and retrieval)
  - CAD Independent Backup



- Data Migration
  - CAD Version Upgrade
  - CAD to CAD

CATIA v4 → v5

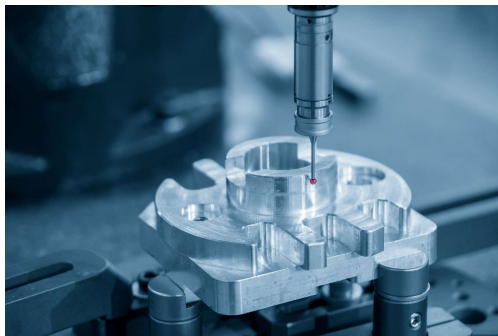
- Supply Chain





# What is the target application?

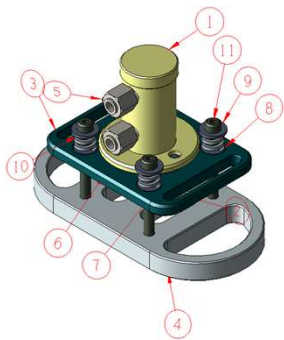
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Quality

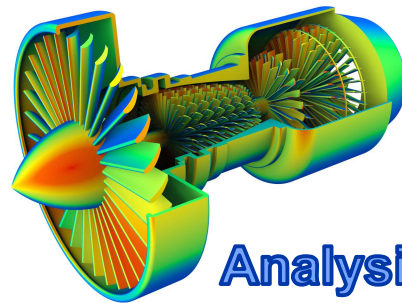


Manufacturing

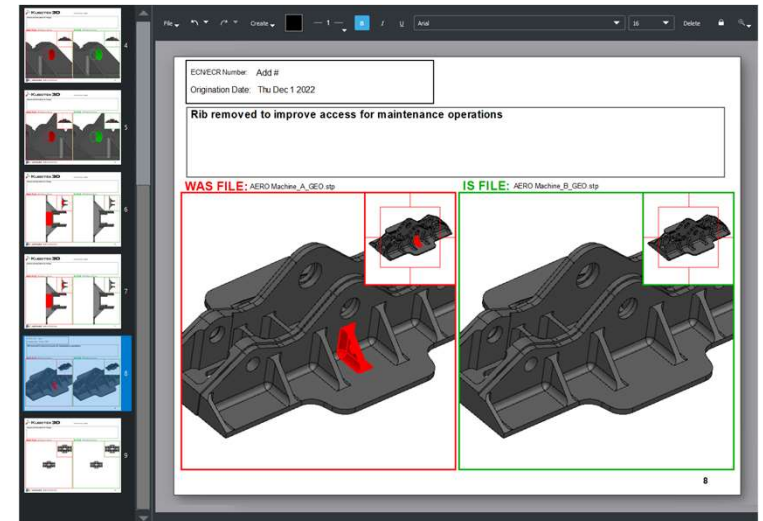


Item	Dty.	Part No. / Description
1	1	Pneumatic Cylinder
2	1	Piston
3	1	Base Plate
4	1	Press Plate
5	2	Quick Connect Fitting
6	3	1/4- 20 Hex Bolt
7	3	.25 Lock Washer
8	4	Bushing
9	4	Washer
10	4	Spring
11	4	2" 1/4-20 SH Shoulder Screw

Purchasing / Quoting



Analysis



Engineering Change

# Data Exchange Considerations

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- Same as authoring software
  - Use the native format!
- Different Software
  - Standard Format (STEP, JT, 3D PDF [PRC], QIF)
  - Kernel Format (Information not easily available)
    - Parasolid
      - SolidWorks, NX, Solid Edge, Mastercam, Onshape (Part Geometry Only!)
    - ACIS
      - *AutoCAD/Inventor*
- ❖ Things to consider
  - ❖ Does the target format have adequate support for all the data?
  - ❖ What are the authoring system's capabilities to write the data to various formats?
  - ❖ Is the target software able to read all required information from the target format?



# Data Conversion Errors – Where and why do they happen?

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## Where?

- Source Data Set
- Derivative format created from source
- Target software read of source data OR derivative format
- Version Upgrades

## Why?

- Software Bugs
- Design Errors
- Gaps in capabilities between source and target formats
- Precision Differences (Varies from  $1e-3$  to  $1e-6$ !) between formats
- Units Mismatch (INCH vs MM)
- Mapping Limitations
  - Geometry (Lines/Arcs/Conics, Planes/Spheres/Cones/Tori) vs Approximate Geometry (NURB/NUB)
  - Topology (Face = Surface + 3D Curve Boundary OR Surface + 2D/Parameter Curve Boundary)
  - PMI Maturity (Annotation Types, Association to Geometry)

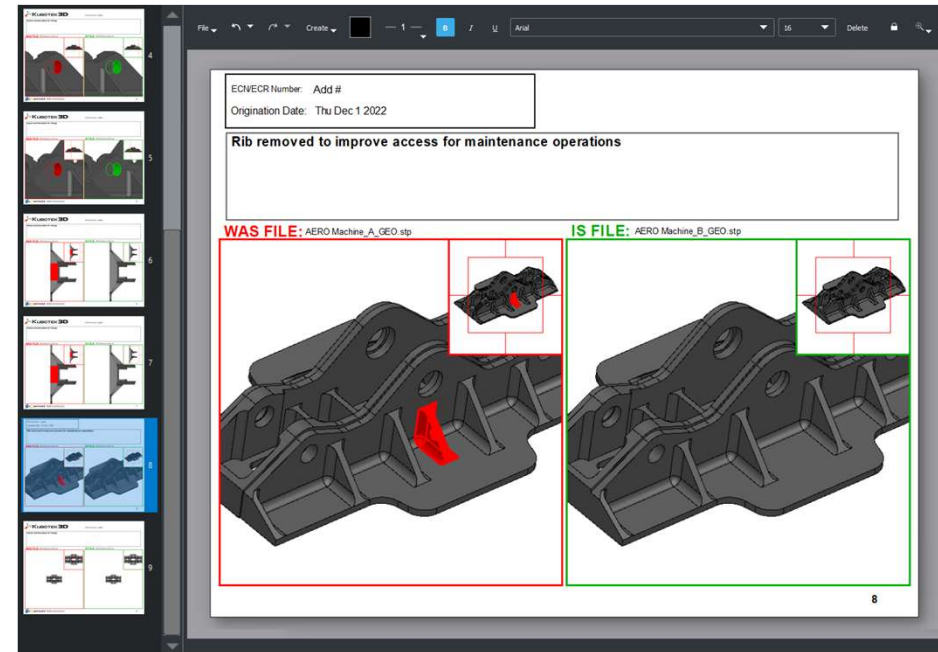
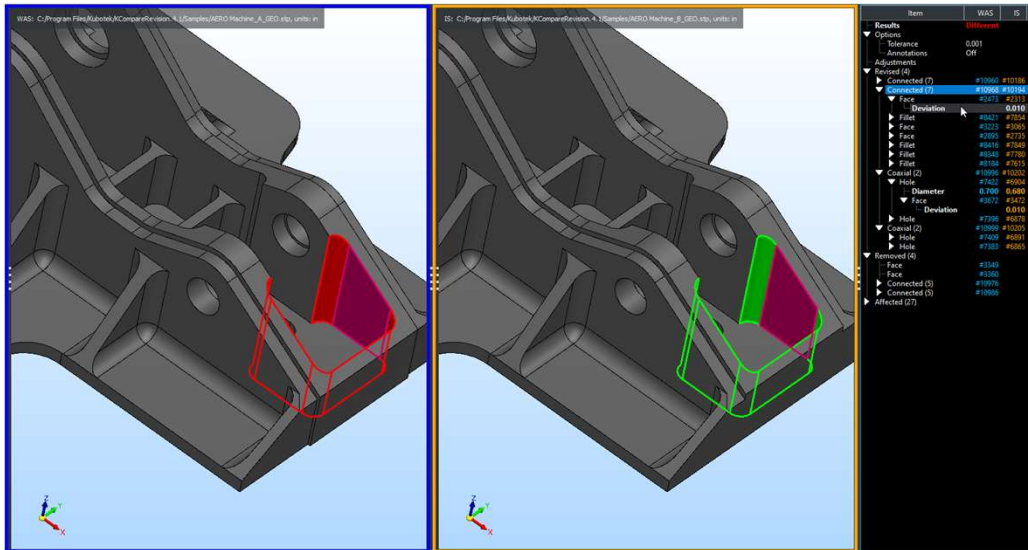
## Define what Data needs to be Exchanged

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- Assemblies?
  - Part Geometry?
  - Mesh (Visualization)
  - Configurations? (Active or All)
  - Construction Geometry?
  - History Tree?
  - Assembly Level Features?
  - Specialized?
    - Publications
    - Composites
    - Electrical
    - Kinematics
    - Selection Sets
  - ❖ Configure part so there is no ambiguity on what is intended to be consumed
    - ❖ Hide or Remove unnecessary information
  - ❖ Visually Communicate Changes (TDP/3D PDF, Report Creation Software – [Kubotek Kosmos Revision](#))
- GD&T?
    - Semantic? Graphical?
    - Part Level? Assembly Level
  - Attributes?
    - Render (Color, Transparency, Line Width, Line Style, Textures, etc.)
    - Material Properties
    - Entity Visibility
    - Entity State (Active or Suppressed)
    - Persistent IDs
    - Part Properties / Parameters
    - Other Metadata
  - 2D Drawings?

# Kubotek Kosmos Revision

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# Data Integrity Checks

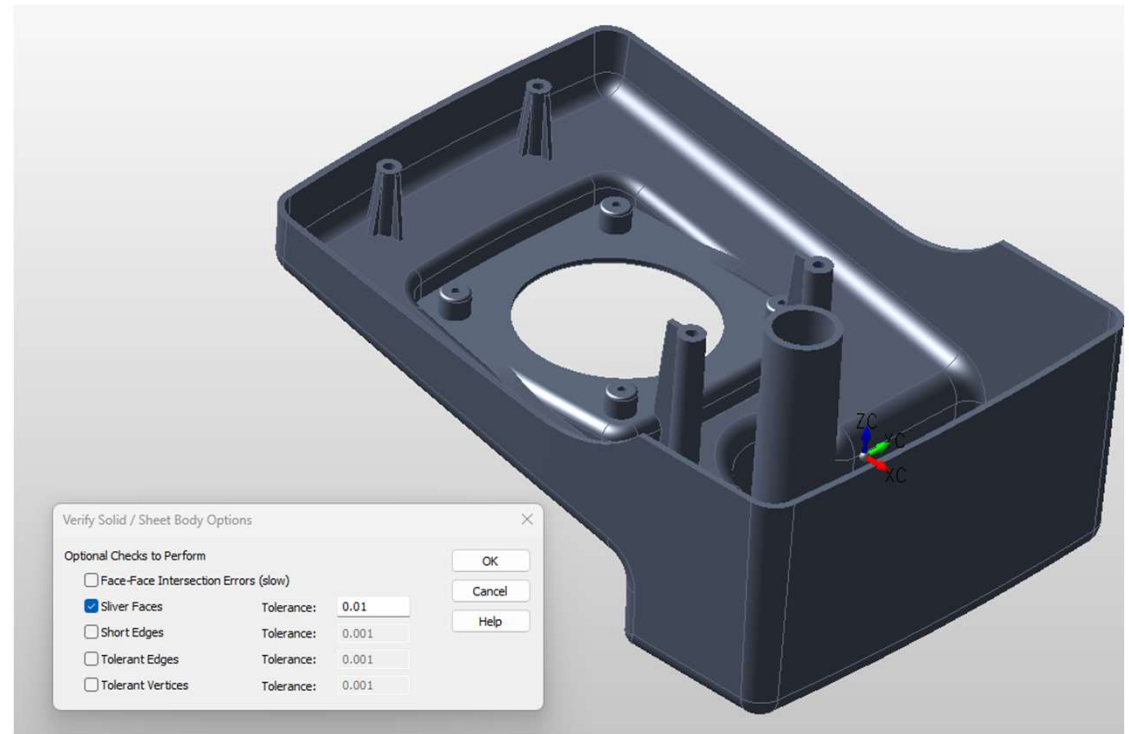
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## Authoring System

- Geometry Checks
- Round trip conversion
  - Check
  - Visual Examination (facets)
  - Overlay ("bitmap compare")
- CAD Independent Validation Tool

## Receiving System

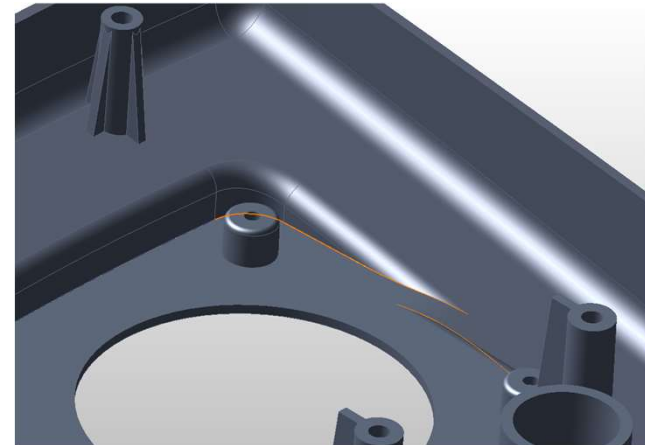
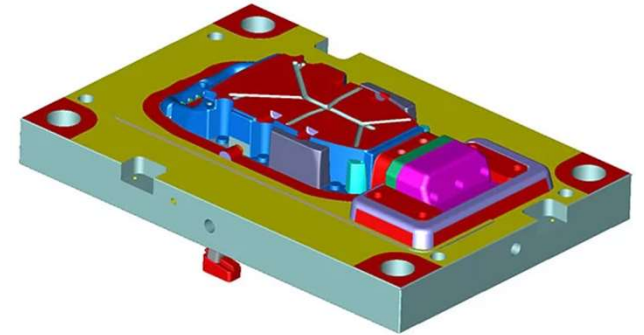
- Geometry Checks
- Visual Examination (facets)
- CAD Independent Validation Tool



## Define Validation Criteria

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- Tolerance
  - Use a reasonable value (ex. 0.01 X smallest machining tolerance)
- Split faces/edges
  - Face colors frequently used by mold designers.
- Sliver Faces / Tiny Edges
  - Cause CAE software problems
- Smart compare
  - Assembly Files
    - Compare Structure, followed by selective part compare

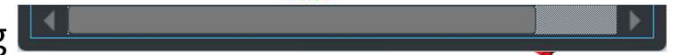
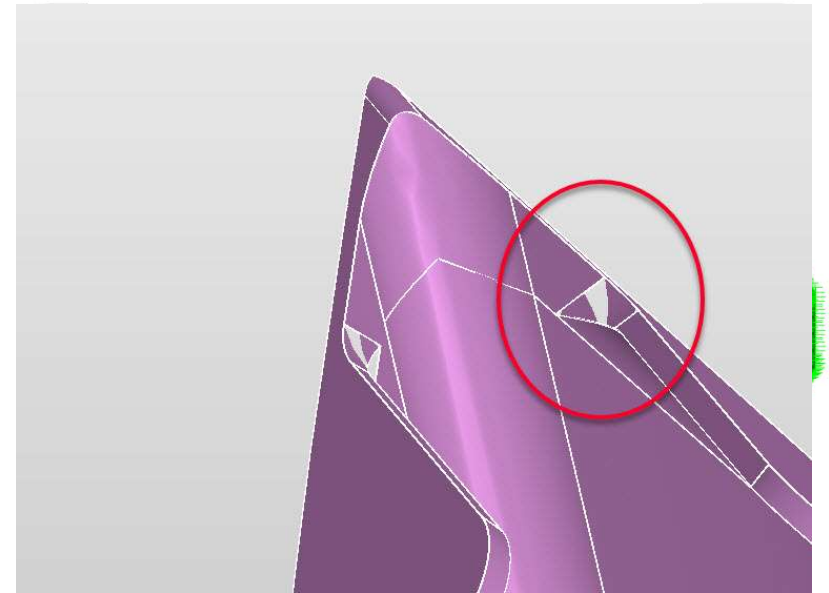


# What to Validate?

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## Minimal Recommended Checks

- Entity Count
- Bounding Box
- Mass Properties (define acceptable deviation)
  - Volume
  - Surface Area
  - Center of Mass
- Point Grid
  - Quick check.
  - Point to face routines typically robust in geometry kernels.
- Graphical anomalies
  - Faceting issues can be an indication of problems with underlying
  - PMI text doesn't look right – invariably caused by use of CAD proprietary fonts or complex text attributes.





# Validation Software - Comprehensive Check

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Authority: C:\Program Files\Kubotek\KCompare\validate.3.2\Samples\Authority\triple-clamp-errors.stp, units: mm

Derivative: C:\Program Files\Kubotek\KCompare\validate.3.2\Samples\Derivative\triple-clamp-transform.stp, units: mm

Face #3455  
Different Faces  
Difference Value = 0.002

Item	Value
<b>Comparison Results</b>	
Options	
Tolerance	0.001
Faces/Surfaces	On
Wires	Off
Points	Off
Points to Faces/Surfaces	Off
Points to Points	Off
Annotations	Off
Compare direction	Both Directions
Derivative Adjustments	
Different (1)	
Authority Face #4083, Derivative Face #3455	0.002
<b>Matched (269)</b>	
<b>Partially Matched (20)</b>	
Authority Face #4374, Derivative Face #501	
Authority Face #4367, Derivative Face #1807	
Authority Face #4366, Derivative Face #2100	
Authority Face #4353, Derivative Face #94	
Authority Face #4346, Derivative Face #4232	
Authority Face #4339, Derivative Face #1596	
Authority Face #4332, Derivative Face #3140	
Authority Face #4325, Derivative Face #1949	
Authority Face #4316, Derivative Face #154	
Authority Face #4309, Derivative Face #1058	
Authority Face #4301, Derivative Face #2093	
Authority Face #4292, Derivative Face #1020	
Authority Face #4285, Derivative Face #3877	
Authority Face #4255, Derivative Face #4351	
Authority Face #4246, Derivative Face #2363	
Authority Face #4237, Derivative Face #1344	
Authority Face #4230, Derivative Face #3037	
Authority Face #4205, Derivative Face #1101	
Authority Face #4196, Derivative Face #2113	
Authority Face #4189, Derivative Face #2382	
Authority Face #4180, Derivative Face #1197	
Authority Face #4173, Derivative Face #1973	
Authority Face #4166, Derivative Face #4203	
Authority Face #4159, Derivative Face #2040	
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Authority Face #4106, Derivative Face #4000	
Authority Face #4099, Derivative Face #2529	
Authority Face #4092, Derivative Face #1595	
Authority Face #4076, Derivative Face #1664	
Authority Face #4069, Derivative Face #3396	
Authority Face #4060, Derivative Face #1276	
Authority Face #4055, Derivative Face #1644	
Authority Face #4046, Derivative Face #2402	
Authority Face #4039, Derivative Face #2182	
Authority Face #4032, Derivative Face #342	
Authority Face #4025, Derivative Face #2751	
Authority Face #4014, Derivative Face #992	



## Summary

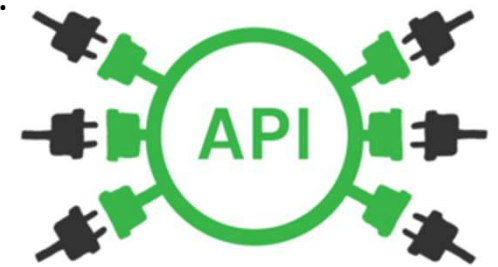
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- Ensure Data Integrity at Source
- Limit data access/transfer to what is intended to be consumed
  - Reduces size of data
  - Ensures proprietary data does not slip through
  - Fewer points of failure
- Choice of vehicle
  - ❖ Does the target format have adequate support for all the data?
  - ❖ Is the target software able to read all required information from the target format?
  - ❖ What are the authoring system's capabilities to write the data to various formats?
- Validate authority and derivative files (both on sending side and receiving side)
- Document changes to prevent miscommunication.

## What tools are available?

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- Utilities within CAD software
  - Often limited
  - Self validation useful but minimal in scope
- Specialized end user products (Kubotek Kosmos Validate/Revision)
  - Functionality can possibly be accessed via
    - SDK (Software Development Kit) that wraps end user functionality in an API interface.
    - Command Line Access with a configuration file
    - Scope limited to how the end user product was designed and its purpose.
- API Libraries
  - Flexibility – Access and use your data the way you want to
  - Automation – Easier to integrate with PDM.
  - Batch Processing
  - Build custom tool to view differences



# Kubotek Kosmos 3D Framework

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1. Geometry Kernel
2. Multi-Processor Enabled - Built to be thread safe from the ground up.
3. Variable Precision Modeler - Designed to work with parts created in different geometry kernels.
4. CAD Neutral Universal Geometry & Topology Database (Assemblies, 3D, PMI, 2D, Meshes, Attributes, ...)
5. Support for various CAD formats
  - i. Neutral (STEP, IGES, STL)
  - ii. Kernel (ACIS, Parasolid)
  - iii. Native (Catia, NX, Creo, SolidWorks, Solid Edge, Inventor, AutoCAD)
6. Never Go Dark Code Pool – Daily Releases, 200,000 and growing regression test suite.
7. Platform Independent - Windows, Linux, MacOS, Android, iOS
8. Multiple programming interfaces - C/C++, .NET, Python
9. Multi-Language / Unicode Support, Journaling Support
10. Source code for end user View Product

# Kubotek Kosmos 3D Framework Capabilities (Modules)

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- ❖ Core (Geometry/Topology, Feature Recognition, Faceter, Model Query, Part History, ...)
  
- ❖ Modeling (Entity Creation, Model Simplification, Modification & Repair, Hidden Line Removal)
  
- ❖ Graphics (Display Library for Selection, Rendering, View Manipulation, Cutting Plane, ...)
  - Display (Client – OpenGL 3 based)
  - WebGL (Browser)
  
- ❖ Compare
  
- ❖ Data Exchange
  - Neutral Format 1 (STEP, IGES, ACIS, STL – Read & Write)
  - Neutral Format 2 (Parasolid, JT, VDA, IFC – Read Only)
  - Direct CAD 3D Read (Catia 4/5/6, Creo, NX, SolidWorks, Solid Edge, Inventor, AutoCAD)
  - Direct CAD 3D Write (Parasolid, NX, SolidWorks, JT, Catia 5)
  - Direct CAD 2D Read (Catia 4/5, Creo, NX, Solid Edge)

# 3D Framework – Format & Application Support

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