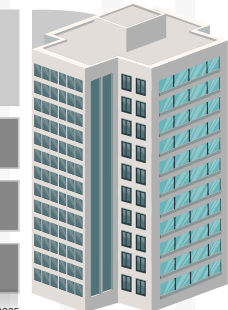


EVOLUTION OF CONSTRUCTION CAD (BIM) DATA STORAGE FORMATS



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Geometric properties of project entities

Attribute properties of project entities

COMPARATIVE ANALYSIS OF FILE FORMATS FOR CONSTRUCTION PROJECTS

	Excel*	AutoCAD*	MicroStation*	AutoCAD* DXF	Tekla	ArchCAD*	IFC	FBX	Navisworks*	SketchUp*	Revit*	BlenderBIM	BIM 360* & ACC	Online CDE	BEXEL	SYNCHRO*	GBXML	ITWO*/MTWO*	PRIMAVERA*	ACONEX*	PROCORE*	GLTF	Unreal Engine*	Pico* & NVIDIA*	DataDrivenConstruction	
Year published	XLM 1985, XLSX 2007	1982	1982	1982	1987	1987	1991	1996	1997	2000	2000	2019	2020	2020s	2010	2005	1999	2004	1983	2000	2002	2015	1998	2016	1987 & 2004	
Developer	Microsoft*	Mike Riddle / Autodesk*	MicroStation*/Intergraph*	Autodesk*	Tekla Corporation*	Graphisoft*	TU Munich	Kaydara* / Autodesk*	Lightwork D / Autodesk*	Last Software / SketchUp*	Charles River Software*	OpenBlender*	Autodesk*	Different	BEXEL Consulting*	Synchro Software	Green Building Studio, Inc	RB Software*	Koppelman & Faris	Aconex Ltd*, Oracle*	Procure*	Chris Tooley* Courtenay*	Khronos Group* (Google, Apple, Intel, NVIDIA...)	Epic Games*	Pico*	Microsoft* & Khronos group*
Purpose of creation	Calculations, analyze and visualize data	Used in CAD applications	Used in CAD (BIM) applications	Interoperability between CAD software	Used in CAD (BIM) applications	Used in CAD (BIM) applications	Interoperability between CAD (BIM) software	Exchange of data between 3D application	Data management and 4D-8D use cases	Data management and 4D-8D use cases	3D model storage	Work with IFC format	Data management and 4D-8D use cases	Data management and 4D-8D use cases	Data management and 4D-8D use cases	Data management and 4D-8D use cases	Environmental analysis data	Data management and 4D-8D use cases	Project management and collaboration tools	Data management and 4D-8D use cases	Data management and 4D-8D use cases	Simulations, visualization and project assets	Simulations, visualization and project assets	Simulations, visualization and project assets	Data management and 4D-8D use cases	
Importing data from formats	RVT, IFC, DWG, DXF, ...	DXF, DGN, STP, ...	DWG, DXF, IFC, ...	DWG, DGN, RVT, IFC, ...	IFC, DWG, DXF, ...	DWG, DXF, IFC, SKP, ...	RVT, DWG, IFC, DGN, SKP, ...	RVT, IFC, OBJ, DAE, ...	RVT, DWG, IFC, DGN, SKP, ...	DWG, DXF, IFC, DAE, ...	DWG, DXF, DGN, IFC, SKP, ...	OBJ, FBX, 3DS, DAE, STL, ...	RVT, IFC, DWG, IFC, DGN, ...	RVT, DWG, IFC, DXF, DAE, ...	RVT, IFC, DWG, NWC, ...	RVT, IFC, DWG, DGN, NWC, ...	RVT, IFC, DXF, ...	RVT, IFC, DWG, DGN, ...	XLS	RVT, IFC, DWG, NWC, ...	RVT, IFC, DWG, DGN, NWC	RVT, IFC, DXF, NWC, ...	RVT, IFC, FBX, OBJ, ...	RVT, IFC, DWG, DGN, NWC	RVT, IFC, DWG, DGN, NWC	
Storage	Tabular	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Cloud-based	Cloud-based	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Tabular	Cloud-based	Cloud-based	Hierarchical	Hierarchical	Tabular & Hierarchical	Tabular & Hierarchical	
Data structure	Structured Data	Closed Data	Closed Data	ASCII	Closed Data	Closed Data	Semi-Structured Data	ASCII	Closed Data	Closed Data	Closed Data	Semi-Structured Data	Closed Data	Closed Data	Semi-Structured Data	Closed Data	Semi-Structured Data	Semi-Structured Data	Structured Data	Closed Data	Closed Data	Semi-Structured Data	Closed Data	Semi-Structured Data	Structured Data	
Open format	Green	Red	Red	Green	Red	Red	Green	Green	Red	Red	Red	Green	Red	Red	Green	Red	Green	Green	Red	Red	Red	Green	Red	Green	Green	
Don't need the internet to work	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Parametric geometry creation	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Creating & modifying entity geometry	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Checking geometric collisions	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Creating & modifying entity attribute	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Quality of data	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Visualisation of entity geometry	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Completeness of geometry	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Creation of drawings	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Integration with other tools	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Community	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Grouping & filtering	1 line of code (Python Pandas)	Only UI	Only UI	Only UI	30+ lines of code	30+ code lines (DGN)	30+ code lines (ACD/Revit)	5+ code lines (FBX SDK)	30+ code lines (Python Shell)	Only UI	30+ code lines (Dynamo)	30+ code lines (KODOL)	30+ code lines (Forge)	30+ code lines (Forge)	30+ code lines (API Console)		10+ lines of code (Python)	10+ lines of code (Python)				10+ lines of code (Python)	10+ lines of code (Python)	10+ lines of code (Python)	1 line of code (Python Pandas)	
Calculations 4D, 5D, 6D, 7D	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
No API Restrictions	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Batch Processing	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Don't need CAD (BIM) tools to work	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Difficulty in handling data	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Versioning and change management	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Support for data analytics	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Creating dashboards	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Easy to create data processing tools	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Compatible with ERP Systems	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
The ability to create Big Data	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
ML and AI support without ETL	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Usage in ChatGPT	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	
Primary application ecosystems	Almost any sector requiring data analysis	CAD Software	CAD Software	CAD Software	CAD (BIM) Software	CAD (BIM) Software	CAD (BIM) Interoperability Format	Interoperability, 3D modeling, animation, and game development	Project Review Software	CAD (3D Modeling) Software	CAD (BIM) Software	3D modeling and animation software	Cloud-based Viewing and Data Management Platform	Cloud-based Viewing and Data Management Platform	4D-5D use cases, Construction Project Information Management	4D-5D use cases, Construction Project Information Management	6D-7D use cases, Energy analysis in building design	ERP, 4D-5D use cases, Construction Project Information Management	4D Project scheduling, Tracking, and Management	Managing documents, processes, and communications in large-scale projects	Project management, resource coordination, and communication in construction projects	3D rendering and virtual reality platforms	Real-time Rendering Engines	High-end rendering and animation platforms	ERP, 4D-5D use cases, Construction Project Information Management	
Main users of the format	Project Managers, BIM Coordinators & Manager's	Planners, Architects, Designers	Planners, Architects, Designers	Planners, Architects, Designers	Planners, Architects, Designers	Planners, Architects, Designers	BIM Coordinators, BIM Managers	AR/VR, Game Developers, 3D Designers	Project Managers, BIM Coordinators & Manager's	Architects, Interior Designers	Planners, Architects, Designers	Planners, Architects, Designers	Project Managers, BIM Coordinators & Manager's	Project Managers, BIM Coordinators & Manager's	Project Managers, BIM Coordinators & Manager's	Project Managers, BIM Coordinators & Manager's	Environmental Engineers, Sustainability Consultants	Projects - Estimators, Logistics Managers, Construction Project Managers	Projects Managers, Logistics Managers, Construction Project Managers	Projects Managers, Logistics Managers, Construction Project Managers	Projects Managers, Logistics Managers, Construction Project Managers	Simulation creators, AR/VR, Game Developers, 3D Designers	Simulation creators, AR/VR, Game Developers, 3D Designers	Simulation creators, AR/VR, Game Developers, 3D Designers	Project, Estimating, Logistics Managers, Construction Project Managers	
Usage	Widely used across all platforms	Autodesk* AutoCAD*	Bentley* Systems MicroStation*	Autodesk* AutoCAD*	Tekla Structures	Graphisoft* ArchCAD*	OpenBIM* ARCHICAD*, Tekla*, Revit*, Vectorworks*, BlenderBIM	Autodesk* Forge*, Autodesk* BIM 360*, Autodesk* Construction Cloud*	Autodesk* Forge*, Autodesk* BIM 360*, Autodesk* Construction Cloud*	Autodesk* Forge*, Autodesk* BIM 360*, Autodesk* Construction Cloud*	Autodesk* Forge*, Autodesk* BIM 360*, Autodesk* Construction Cloud*	Blender	Autodesk* Forge*, Autodesk* BIM 360*, Autodesk* Construction Cloud*	BIM 360*, Forge based, Bentley* ProjectWise*, Trimble* Connect, Procore* and others	Bentley* Manager	Bentley* ecosystem, Synchro* software	Autodesk* Green Building Studio	SB* ITWO, MTWO Construction Cloud	Oracle* Primavera P6	Oracle* Construction and Engineering suite	Mobile applications, enabling use on various devices in the field or office	Microsoft* Mixed Reality Toolkit, Facebook* 3D Posts, Sketchfab, Three.js	Unreal Engine*	NVIDIA* Omniverse*, Apple* ARKit, Pico* USD tools	Excel* Python Pandas, Unreal Engine*, PowerBI, ChatGPT, Unreal Engine	
Popular usage platforms		2D	2D	2D	3D	OPEN BIM*	OPEN BIM*	BIM	4D 5D	3D	BIM 360 ACC	BIM	BIM	4D 5D	4D 5D	BIM	6D 7D	BEM	4D 5D	ERP	4D	4D 5D	4D 5D	4D 5D		

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STRUGGLE FOR OPEN DATA IN CONSTRUCTION

TrustedDWG, AutoCAD, closedBIM, openBIM, Revit, SDK, IntelliCAD, OpenDWG, CPXML, IFC SDK, OpenCASCAD

WARS OVER DATA IN CONSTRUCTION

BOM, BIM, STEP, IFC, AIA

openBIM, buildingSMART

FREE STANDALONE CONVERTERS

IFC CONVERTER, STEP CONVERTER, DWG CONVERTER, DGN CONVERTER

LLM AND CHATGPT WITH REVIT, IFC AND DWG

OpenAI, Revit, IFC, DWG