AUTODESK UNIVERSITY

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# IFC in Autodesk – The Next Generation

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## Learning Objectives

- Learn about how buildingSMART International Infrastructure and Railway rooms have undertaken the development of IFC 4.3.
- Understand how new IFC 4.3 capability is being implemented in Autodesk software.
- Be confident in applying IFC 4.3 in live projects, understanding what it can offer and how it should be adopted.
- Become familiar with new investments Autodesk is making in supporting IFC in software.

## Description

Autodesk established the Industry Alliance for Interoperability back in 1994 inviting twenty software companies to work on neutral exchange formats for industry. This became the International Alliance for Interoperability (IAI) two years later opening participation to any interested parties, which was renamed again as buildingSMART International (bSI) in 2005. bSI and its members develop and maintain the industry foundation class (IFC) data model and Autodesk has been an active supporter of the development of IFC and included import and export capabilities in many solutions for evolving IFC releases, such as for IFC 2x3 and IFC 4 that were adopted as ISO 16739:1 in 2006 and ISO 16739:2 in 2013 respectively. bSI has now extended IFC from mainly building elements to cover infrastructure entities as IFC 4.3, which is set to become ISO 16739:3 in 2023. This presentation will detail how Autodesk has been involved in the development of IFC 4.3 to ensure its suitability to industry requirements and compatibility with engineering software. In the class Autodesk Product Leads will cover how it is transforming IFC support by adopting the Open Design Alliance (ODA) IFC toolkit for a range of its products, has implemented pioneering infrastructure support for IFC 4.3 within Civil 3D and through new investments is working to extend IFC capability across a wide range of solutions.

## Speaker

Marek is a Senior Global Business Development in Autodesk focused on the infrastructure sector and the development of industry standards for BIM and data exchange. He holds a

degree in Civil Engineering, is a Chartered Engineer, Chartered IT Professional, a Fellow of the British Computer Society and the Institution of Civil Engineers and a Member of the Chartered Institution of Civil Engineering Surveyors (CICES). He is a member of the British Standards B555 committee that prepared UK and subsequently ISO 19650 BIM Standards, he is a nominated subject matter expert to CEN (European Standards Committee) for Common Data Environments (CDE) and BIM for Infrastructure, sits on the CICES Geospatial Practices panel, and is Vice Chair of the Technology Group within the UK BIM Alliance. He sits on the buildingSMART International InfraRoom Steering Committee and is Chair of the InfraRoom Project Steering Committee that is preparing new infrastructure schemas.

Angel Velez is a senior principal engineer at Autodesk, Inc. In 1992, he graduated from the Massachusetts Institute of Technology with BS degrees in computer science and mathematics, and he graduated from Stanford University with a master's degree in computer science in 1994. After working in the mechanical CAD industry for 5 years, he joined Charles River Software in 1999 to work on a project that eventually became known as Revit software. Since 2004, Velez has been working primarily on interoperability issues, concentrating on Industry Foundation Classes (IFC). Angel is a committee member of the buildingSMART International Technical Room and has led the development of open source IFC support for Revit that has recently transitioned to the Open Design Alliance toolkit enhancing performance and flexibility.

Nigel Peters is the Autodesk Transportation Product Manager for the AEC Infrastructure Product Development team, which supports Autodesk BIM 360, Civil 3D, InfraWorks, and Vehicle Tracking. Nigel is passionate about bringing transportation solutions to customers and has dedicated many years supporting buildingSMART International efforts to develop a data model and IFC schema for infrastructure. Nigel has led the implementation of IFC 4.3 for Civil 3D providing one of the first to market in product support for the new infrastructure schemas.

## Introduction

Exchanging information between different software solutions seamlessly is seen by many as an expectation whereas the reality is frequent incompatibility, inconsistency of naming, loss of information, displacement and many other interoperability issues. For the engineering community this is particularly pertinent as the data that gets prepared is typically critical to the successful planning, design, procurement, production and operation of assets; any failure in exchanges could lead to errors, waste or other risks in the project execution.

Mitigating such interoperability issues has been a key focus for Autodesk for nearly 30 years, which perhaps underlines that this challenge is complex and difficult to resolve. The establishment of the Industry Alliance for Interoperability that over time morphed into buildingSMART demonstrates Autodesk’s commitment to the cause and desire to cooperate with industry to tackle the issue.

## IFC in practice

Since 2006 IFC 2x3 has been available as a data model for the built environment with a bias towards vertical construction. This was followed by ISO standardisation of IFC 4 in 2013 allowing industry to use either form in the exchange of information. IFC is not just available as an ASCII file but can be encoded in additional forms including XML, JSON, and STEP, it can also be shared using web services, imported/exported in files, or managed in databases.

Many users have been given the wrong impression as to what these schemas can be used for or their coverage leading to disappointment with its value and/or support in software. There are however many who have recognised that IFC provides a data model that permits consistent description of assets, attribution, relationships as well as allowing for processes such as analysis or takeoff to be carried out against a standardized data structure.

There are some key specific use cases that are explicitly excluded, key amongst these is the concept of round-tripping. IFC is in the main a snapshot of a model that will not include the design rules or logic used to prepare the model. So, if an export is made from authoring software, subsequent import will typically only retain the geometry and attributes, but not allow for further design update or change; if this workflow is desired then native exports need to be created alongside the IFC.

## IFC 4.3

A major shortcoming of IFC 2x3 and 4 has been support for infrastructure entities. This led to the establishment of the Infrastructure Room in 2013, where the participants sought to identify core entities that would permit valuable exchanges between infrastructure software and as a data handover to owners.

The first output from the Infrastructure Room was IFC 4.1 for alignment published in 2018. This was a new concept within IFC as it was in principle a linear reference to allow coordination along the profile of the alignment or as a line and offset, which are typical methods that infrastructure assets are located eg at chainage 1200m and offset 2.3 to the right. The additional value of the alignment is that should the profile of the asset eg road, rail or pipeline change, an update of the alignment would only need to be shared to allow associated point assets to be correctly relocated rather than re-calculation of their cartesian coordinates (x, y, z).

IFC 4.2 was released in 2019 for a standardized bridge definition. But by this time the projects for road, rail, ports & waterways and common schema elements were already underway, that also altered some of the alignment and bridge definitions, as a consequence 4.2 along with 4.1 was withdrawn for use.

IFC 4.3 that included infrastructure and rail definitions was finalized in 2021 and is in the process of being approved as an ISO 16739 updated schema, which is expected in 2023. There is work currently underway to deliver defined Model View Definitions (MVDs) for specified exchanges eg coordinate based reference view, alignment based reference view, rail alignment cant, rail track structures or bridge. Some of the core MVDs will be used for software certification for import or export, which is anticipated to commence before the end of 2022

The importance of the MVD development alongside ISO approval is that owners or project teams will have greater confidence in specifying use of IFC 4.3 for project or asset handover against defined use scenarios, knowing also that there will be certified software available for certain use cases. IFC 4.3 cannot cover all possible exchanges, but where it does satisfy a requirement it can be used knowing there will be a consistent and reliable data and geometry exchange.

## Autodesk IFC support

Autodesk has been supportive of IFC schemas from the outset. As IFC has become more established, used in workflows and available as an ISO standard, Autodesk has invested in providing IFC export and/or import in many products.

At present IFC 2x3 ISO 16739:1 in 2006 is supported in 15 solutions with Revit, Revit LT and AutoCAD being certified for Coordination View 2.0 import and export. IFC 4 was approved as ISO 16739:2 in 2013 and has more granular certification MVDs where Autodesk Revit has been certified for Architectural reference exchange export, Structural reference exchange export and MEP reference exchange export, with IFC 4 import certification currently in progress.

Autodesk was the first software company to provide in-product import and export support for IFC 4.1 alignment when it was released, and has maintained closed involvement in the Infrastructure Room for the IFC 4.3 extension programme for infrastructure entities and rail, already providing pre-certification support for the schema in Civil 3D and Revit for users to test.

Many of Autodesk's IFC import or export solutions are custom developments, meaning there is a maintenance challenge, sometimes leading to a delay in releasing updates to modified schemas. To partly address this the Revit IFC implementation has been available as an open source solution for over 10 years permitting users to modify or extend IFC support e.g for custom entities, and has recently adopted a new toolkit from the Open Design Alliance (ODA). This ODA toolkit is also being extended to other products such as Inventor, Navisworks and the online model viewing capability in the Autodesk Construction Cloud to provide improved performance and support the IFC 4.3 entities.

Autodesk is looking to further democratise support for IFC in its CAD and modelling solutions by providing IFC exchange capability in the Autodesk Translation Framework (ATF). ATF is a long-term project aimed at delivering rich and consistent interoperability between Autodesk's own solutions. By adding IFC to this capability, Autodesk will have confidence that any of its solutions that can read or write to ATF can also support IFC. This will take time to complete but is expected to replace the local solutions currently in place.

## Further Reading

For users who wish to find out more about buildingSMART, IFC and how Autodesk supports there is a lot of information available, some of which is referred to above and includes:

- Interoperability and Autodesk support *www.autodesk.com/interoperability*
- Addons for Autodesk tools to support data requirements *interoperability.autodesk.com*
- Civil 3D IFC toolkit https://feedback.autodesk.com/welcome
- buildingSMART InfraRoom *www.buildingsmart.org/standards/rooms/infrastructure*
- Announcement of the release of the IFC 4.3 report *www.buildingsmart.org/the-infra-and-railway-rooms-deliver-major-4-3-implementation-and-validation-report/*
- IFC Technical Overview and Survey of Autodesk Products https://www.autodesk.com/autodesk-university/class/IFC-Technical-Overview-and-Survey-Autodesk-Products-Including-Revit-2017-2016