buildingSMART International (2022)
341-DESIGN BUILDINGS Design for Buildings using openBIM

Life-cycle openBIM at Norwegian Viking Age Museum

gKLGqPzL

Entrant details

Role or Job Title on the Project	Chief Architect
Employer	
Statsbygg, Oslo, Norway	
Employer Role	Public Sector Owner/Client
Are you or your employer a member of buildingSMART?	Yes - Chapter Member

Entry details

Entry Details

By checking this box I understand and acknowledge that this awards program is to assess information about openBIM, and that openBIM is not only about the use of solutions. openBIM is about setting up an environment where every party in a team can work in the optimal way ("how they prefer") without putting limitations on others. It is about freedom to take control over your data and workflows, while keeping that freedom for others as well. Full use of open standards is not mandatory for this mission.	✓

Location

Statsbygg
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Submitting Party and Stakeholder Logos (compiled into one .ppt/pptx file for upload)

PPTX	Statsbygg_AEC3_Logos.pptx (101 KiB download)

Entry Description

Statsbygg is the Norwegian Governments counselor, client, building commissioner, owner, and operator for approximately 2300 government buildings and 150 ongoing design/ construction projects.

Since 2011 IFC information exchange and handover has been mandatory for all projects.
Statsbygg is committed to openBIM due to several reasons. The most important are:
• We want free competition to reward the best solutions.
• We want to express our information requirements in one standardized format (IFC).
• Easier coordinate of our requirements and information standards with other client organizations.
• Standardized information handover for FM, maintenance and building operation.

This entry includes four openBIM workflows. However, the first workflow is the main subject of this entry. Statsbygg's incentive to submit for the award is not commercial, but to raise awareness of the importance of information quality and standardization. We believe many other clients will benefit from setting specific information requirements and automatically check model according to the requirements.

The four openBIM workflows described in this entry:

1. openBIM requirements and model checking (alpha-numerical information). Conditional for the efficiency of the following workflows:
2. Project dashboard including:
   a. Cost estimation. Pivotal design management information.
   b. Project status. Pivotal project management information.
3. Simulated Viking ships transportation. Addresses a specific project challenge and demonstrate possibilities for innovation.
4. As-built digital FM handover. Important information to maintain the value of the building in its lifetime.

The Viking Age Museum (VTM, Norwegian abbreviation from Vikingetidsmuseet) is a prestigious project, adding new exhibition areas, education facilities and a café to a refurbishment of the existing museum. The project is challenged by complex building geometry and advanced technical installations. Other challenges are that the building extension shall be integrated seamlessly to the existing building and handling of the fragile Viking ship is demanding.
openBIM is utilized to overcome these and many more challenges and to secure uniform information for efficient project management, design-to-cost and as-built handover.

1. openBIM requirements and model checking (alpha-numerical information)
   In collaboration with AEC3 Germany, Statsbygg has developed a standardized workflow, applying to all our projects, to quality assure all model deliverables. Central piece of the workflow is the specification of information requirements for model deliveries.
   Current iteration of the solution checks the existence of the information item within the required property sets. In

order to check allowable values deeper, we are developing Regular Expressions for the most pivotal information such as naming and classification. While the buildingSMART standard mvdXML can be used sufficiently to validate the provision of required information, the deeper check using RegEx requires the enhancement of mvdXML or its support within the new IDS development.
All quantitative alphanumerical information requirements on object level are documented in the requirement database, BIMQ. The database is developed together with and provided by our German partner AEC3 Deutschland GmbH.
Statsbygg has developed an information standard coordinated with other large public Norwegian client organizations. Based on this information standard Statsbygg has developed a generic requirement set describing the need for an "average commercial building". Since no projects are 100% average, all projects are provided with a copy of the generic requirements and the requirements set are then optimised for the specific project. The BIM delivery agreement process follows the methodology described in ISO 19650-2 and CEN/TR 17654.
The requirements can be reported as human readable requirements in PDF or ODT reports specific for each discipline and project stage.

2. Project dashboard
   2.a. Cost estimation
   Cost control is crucial to the project execution. Project cost is the pivotal factor deciding whether a project can be executed or not. Cost estimation based on building area is not precise. Detailed cost estimation based on drawings are time consuming and are prone to errors. openBIM based cost estimation is precise and efficient. Norwegian cost estimation is based on standards for building specification, classification, production quality. This makes it relatively easy to streamline model information for cost estimation.

2.b. Project status (model maturity, issues and geometrical information).
In the VTM project we have developed a project dashboard that can be used by all Statsbygg projects.
The dashboard extracts key information, important for decision making and QA.
Areas (Gross/Net), number of objects pr. control zone, Process status on objects, Issues (PPC), cost analysis (construction, LCC and CO2), visualization (BIM-viewer).
This gives a more nuanced and correct picture of the project status instead of the more commonly assessed 50% or 80% completion.

3. Simulated Viking ships transportation.
   One of the most challenging activities is the transport of the Viking ships. The location of the museum was to some degree chosen for the ships to move as little as possible. An alternative location in the center of Oslo was dismissed due to the risk of physical stress of the longer transportation of the ships. During the construction the ships are stored in the existing building.
   When the museum building is finalized, the ships shall be moved into their permanent location. All the ships are scanned and modelled as IFC-files. The transportation of the ships into the new buildings is simulated utilizing the IFC-objects of the Viking ships. Using Augmented Reality (AR) it is possible to monitor, in real time, whether the ships follow the planned route through the museum.

4. As-built digital FM handover
   Statsbygg's want to manage, operate and maintain all our 2.300 buildings based on digital, standardized information without individual adjustments.
   We require projects to handover models for FM and building operation. Design changes during construction are normal due to production optimalization. Statsbygg has specified a standard procedure applicable to all projects to ensure models are updated with design changes during the construction stage.
   The digital twin handover is an integral part of the building documentation. Statsbygg has implemented a common openBIM, solution, Dalux FM, for building operation.
   Dalux FM gives access to updated geometrical and alphanumerical information together with links to documentation. Statsbygg uses a Norwegian implementation of ISO 81346 for identifying systems and objects allowing automated linking between the models and documentation.

What stage of completion is the entry content representing?	Coordinated design (ISO 29481-1:2016, table A.1) The project is executed as a turn-key contract. The turn-key contractor AF Group, the design team, main subcontractors and Statsbygg are planning construction.

Stakeholder Statements

> Thomas Liebich, CEO, AEC3: "Statsbygg has been an innovator for standardized digital workflows from an owner perspective since the beginning. When we started to replace our traditional Excel-based production of exchange requirements by a cloud-based solution in 2013, the prerunner of BIMQ, Statsbygg had been our first beta-user. Since then, we are proud to support the ever-increasing demands on digital workflows for information requirements and delivery validations."
>
> Harald Nikolaisen, CEO, Statsbygg:
> "In Statsbygg we believe that digital, structured information is an important tool for sustainable design, construction and building operation. All information regarding all building projects and building operation in Statsbygg shall be digital, machine-interpretable, and open format."
>
> Anders Fylling, Director Professional Competence Center, Statsbygg:
> "Information shall be accessible across projects and project stages. Open BIM is the main source of information in building projects and a pivotal source of information in building operation. All collaboration and deliverables in building project is openBIM (IFC)."
>
> Omar Manaf, BIM Leader in VTM Project, Statsbygg:
> "Combined with Augmented Reality, openBIM models of the existing building, the new building and the large Iron Age objects like the Viking ships makes it possible to really understand the challenges and complexity of safeguarding and transportation and thus reduce risk during execution."
>
> Steen Sunesen, BIM group leader, Statsbygg:
> "All projects deliver building information according to a common information standard. Statsbygg's open BIM requirements, using the requirement database BIMQ, is a common information standard, a set of generic requirements and a methodology for checking model deliverables automatically."

Upload a 2 minute video to show the scope of the entry.

MP4	Statsbygg-VTM_EntryScope-... (103.4 MiB download)

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openBIM Claim

Detailed description of openBIM used on the project or initiative

> 1. openBIM requirements and model checking (alpha-numerical information)
>   The information requirements from BIMQ can be reported as human readable requirements in PDF or ODT reports specific for each discipline and project stage. It is also possible to export them allowing automatic generation of property templates in BIM authoring tools. Unfortunately, there are no open standards yet, therefore this automation must be done using proprietary means of each software.
>   The information requirements can also be reported in a machine-readable format, mvdXML, as validation rules. When uploaded in SimpleBIM, the mvdXML sets the model checking according to the agreed requirements.
>   SimpleBIM checks whether the alpha-numerical information in the IFC deliverables is according to the requirements. Any deviations from the requirements is reported with BCF for efficient communication. If the buildingSMART standard IDS is released and capable to carry on such validation rules, BIMQ would support such a workflow as well. It would include advanced checking rules, such as RegEx.

2. Project dashboard
   The project use BIM360 model server. The VTM project has developed a project dashboard aggregating key management information and makes it available in the project's common communication platform, Teams eliminating thresholds for easy access to the information. The project dashboard also includes a BIM viewer, also integrated in Teams, available for all project participants. Since all Statsbygg's projects are subject to deliver according to the same information standard the project dashboard is available to all Statsbygg projects.

2.a. Cost estimation
IFC models are imported to a Norwegian cost estimation solution, ISY Calcus.
ISY Calcus reads IFC and visualize if elements are linked to a cost. Elements are sorted according to domains by reading a combination of the object type name (IfcRoot.Name) and the element's IFC class.
When a cost estimation is established, updated models can be imported, and only new objects requires linking to costs. Tracking this uses IFC GUID.

2.b. Project status (model maturity, issues and geometrical information).
Information extracted from the project's models gives important information on project status on production, decision making and quality assurance processes.
Basic information like Areas (Gross/Net) indicates status on how the project satisfies the building program.
Statsbygg uses a Norwegian industry standard called model maturity index (MMI) indicating the model's maturity on how they satisfy the agreed requirements.

3. Simulated Viking ship transport
   By the end of construction, the ships can be moved to their permanent location. All the ships are scanned and modelled (IFC). The transportation of the ships into the new buildings is simulated utilizing the Viking ship models. Using AR it is possible to monitor, real time, whether the ship transportation follows the planned route through the museum.

4. As-built digital FM handover
   Models delivered to archive following a standardized procedure for model check, documentation of the project setup. Documentation is delivered through our FM collection tool Omega 365.
   Models and documentations are uploaded to the FM archive solution, Dalux FM and linked together using AI recognition of classification and identification of both BIM objects and systems and documentation.

"We were able to innovate using openBIM."

1. mvdXML for model check
   Together with AEC3 and Datacubist, Statsbygg developed an information flow using mvdXML (originally developed for IFC-certification of software) for model checking. Note that Statsbygg follow the development of IDS and will implement this when supported by our requirement database and model checking tools. AEC3 is also committed to support IDS in its BIMQ solution.

2. Project dashboard
   Statsbygg use Power BI and Vcad to extract and express key information on Microsoft Teams for the project management. Use of model information on an easily accessible platform make BIM information available for all project participants and especially the project management without requiring any specific skills on modelling tools.

3. AR simulation of Viking ship transport
   The preserved Viking Ships are 1000 years old and very fragile. They are stored nearby during construction and will be moved in place when the construction is finalized. The transport of the ships to their permanent location depends on a specific planned route. The ships are scanned and modelled as IFC. The transport is simulated as a movie. The real-life transport will be compared with the movie using AR to ensure that the ship's transportation follow the planned route.

openBIM methods used	✓ IFC 2x3

	✓ IFC 4 ✓ mvdXML
Have you used bSDD to add additional extensions on top of IFC?	No

Were there other regional or open standards used other than those listed above?

EN ISO 19650 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling.

EN ISO 29481-1 Building information models — Information delivery manual — Part 1: Methodology and format

EN 17412-1 Building Information Modelling — Level of Information Need — Part 1: Concepts and principles

NS 8360-1 and -2 BIM-objects - Naming, type encoding and properties for BIM-objects and object libraries for construction works

Level of Collaboration	✓ Multi-domain in two or more organizations

Information Requirements

PDF	Statsbygg-VTM_BIM-require... (1.7 MiB download)

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openBIM Evidence

Software Ecosystem Map

PDF	Statsbygg_BIM_SoftwareEco... (714 KiB download)

Process Maps

PDF	Statsbygg_BIM-ProcessMaps... (594 KiB download)

openBIM Data Metrics Summary

PDF	Statsbygg_VTM-Metrics.pdf (1,024 KiB download)

Additional openBIM Supporting Evidence

PDF	Statsbygg-VTM-Supporting-... (3.9 MiB download)

Lessons Learned

Advantages:

- Hundreds of successfully executed models since 2011 has demonstrated that it is fully possible to work efficiently with openBIM workflow.
- Several successful local and regional openBIM applications has been developed to support different parts of project execution. This demonstrated that openBIM is a platform for further innovation.
- Standardized openBIM requirements across all projects makes development of the industry more predictable. When large client organizations and the National standardization body are coordinated and pulls in the same direction it makes investments into streamlining openBIM worth the effort.

Challenges:

- However, openBIM requires a relative high level of competence among client, architects, engineers, and contractors. Required competence includes both an overall understanding of the importance of delivering standardized structured information and more specific technical competence on how to setup the chosen authoring tools to deliver according to buildingSMART standards.
- Efficient use of openBIM also requires support from software vendors. Unfortunately, not all software supports openBIM in an efficient way. Some software requires advanced knowledge in setting up IFC export. Not all vendors prioritize to support their most advanced user's needs. This is probably the biggest current challenge for getting information according to agreed requirements.

Conclusion:

- Statsbygg has no doubt that integrating openBIM into the project's execution and FM/O&M of buildings is the way forward. But changing the industry from using drawings and documents to become digital, automated, and sustainable is not just a technical task. It requires major changes in business culture, career wise motivation of individuals and economic incentives.
- As one of the regional frontrunners, Statsbygg often find we must initiate and finance development, not only of our own solutions but also general industry standards and software for our projects to be able to deliver properly according to our openBIM standards. We have increased our dialogue with the local software vendors to make sure they support their customer's (architects, engineers, and contractors in our projects) needs to deliver according to our requirements.
- We had preferred that software development was more forward-leaning into use of IFC and other openBIM standards. However, we are still willing to spend both time and money on development since costs of development is often covered by savings on just a few of our many ongoing projects.
- Statsbygg are welcoming that more client and owner organizations are stepping up and are willing to require standardized structured information, share development costs and collaborate with us to harmonize how we require information.

"We were able to identify where we need openBIM to develop further."

1. mvdXML (or IDS) needs to support RegEx for more advanced rule-based check of syntax/allowed value.

2. Development of open standards allowing automatic generation of property templates directly into BIM authoring tools based on information requirements such as BIMQ.

3. GUID shall not change once an object is exported. This is especially important for continuous cost estimation where only new objects should require linking to costs. We experience that some authoring tools for each new IFC export, provides new IFC GUID to objects already linked. This generates much extra work and make it less attractive for projects to utilize the cost estimation process as a continuous project management tool.

4. Maybe not so much development but implementation of existing standards. Statsbygg want to utilize bSDD for translation and expressing user-defined properties in local professional language. BIMQ has recently implemented a first beta-version of a bSDD Connector, so both Statsbygg and AEC3 would be ready to support bSDD when a broader software support will be available.

Upload .ifc file(s) or other technical files to support validation of the research results.	https://service.usbim.com/link/629f14d78df9e6bbe0e5cf08

Share any instructions for accessing the .ifc or other technical files for review.

> Uploaded to usBIM ACCA server a federation of VTM project's IFC models of the new building and one of the Viking ships (the "Oseberg skip (ship)" is one of the largest and most intact Viking ships ever found and considered the crown among the Norwegian Viking ships).

Use Cases

BIM Uses were defined on the project	✓
BIM Uses formed an integral part to how the project was delivered	✓
I agree to be contacted for more information about the project BIM uses outside of this awards program.	✓

Documentation on use case(s) as a single file upload

PDF	Statsbygg-VTM_UseCases.pd... (1.8 MiB download)

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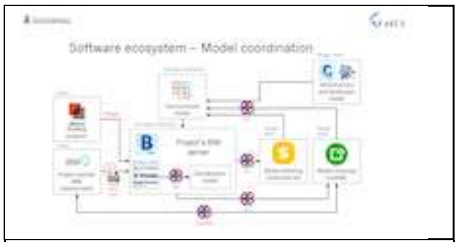
Image

2-VTM_BIMQ.png 140 KiB



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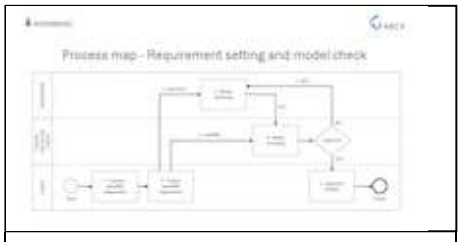

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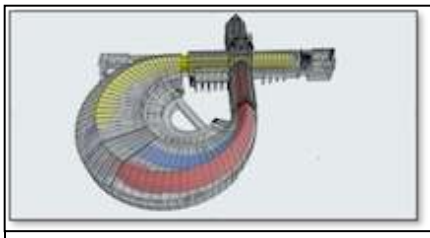

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