

White paper

EU BIM standardisation on infrastructure and construction projects

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Abstract

MT Højgaard has since 2014 analysed the digital 3D basis for projects and published a number of white papers about the importance of standards and framework in our Danish construction industry for increased productivity in infrastructure and construction projects.

During the same period the EU has been working to create an international standardization of digital cooperation on infrastructure and construction projects. EU BIM Task Group¹ published in July 2017 the *Handbook for the introduction of Building Information Modelling by the European Public Sector*. Part of this work is now embarking as ISO and CEN standards that might replace current national information and communications technology (ICT) regulations, such as the Danish ICT regulations 118 and 119 from 2013, see Appendix A.

This white paper seeks to reveal to what extent a new digital collaboration framework, can be implemented and contribute to a framework that will give the construction industry and clients a more effective digital collaboration on the projects than today, as described in the EU BIM Handbook² with support in the form of the upcoming ISO/CEN standards like 19650-2³ standard.

Weaknesses in current digital practice

Analyses⁴ and initiatives in the period from 2014 to 2016 have shown that critical clashes pose an unnecessary temporal and financial risk to the project, but no analyses have shown which initiatives the client can bring into play on a project to reduce the scope of critical clashes.

In February 2017 MT Højgaard analysed the critical clashes in the 3D design of projects that involve a total of more than 2.4 million digital building components distributed across architectural, engineering, ventilation, electricity and HVS models. More than 42% of all critical clashes were found in the interdisciplinary clash detections; see also the white paper *Critical clashes in the 3D design*, February 2017. The extent of these clashes in the 3D design indicated that there was a need for strengthening the practice for the interdisciplinary coordination of 3D design.

¹ <http://www.eubim.eu/>

² *Handbook for the introduction of Building Information Modelling by the European Public Sector, July 2017*

³ *Organization of information about construction works - Information management using building information modelling, 2018*

⁴ *Critical clashes in the 3D design, February 2017*

The mentioned analysis of the quality for the basis of the digital collaboration shows the need for a change.

Future framework for digital cooperation on infrastructure and construction projects

The white paper *Value drivers in the Danish national ICT-regulations*, December 2014, showed among other things that a clear requirements specification of what to do contributes positively to the infrastructure and construction project performance. It also provides a framework for the digital collaboration and coordination of the entire usage of Building Information Modeling (BIM) between all participating companies on the infrastructure and construction project.

The requirements specification like ICT-coordination creates value for both the client and the project see the white paper *The strength of the local BIM efforts in a larger perspective*, May 2016. The Client must ensure that throughout the infrastructure and construction project there is coordination of the overall use of ICT between all of the parties involved. The white papers shows that the client must demand that the framework for digital collaboration requires all parties to ensure that their digital deliveries can be used by and together with other stakeholders on the project.

In July 2017 the EU BIM Task group (The European Union) published the EU BIM Handbook⁵. The EU BIM handbook describes the hard start of digital work on infrastructure and construction projects:

"there is often a lack of clarity and common understanding of where to start, what to do and what defines a "BIM project" versus a "traditional project" (Source: Handbook for the introduction of Building Information Modelling by the European Public Sector, page 26)

The good project basis consists not only of high quality of design material, but also of valuable knowledge regarding the project and its context as well as the derived consequences of the project itself. Together with a well-integrated project collaboration, it increases both the success rate and efficiency of the project, as also indicated in the EU BIM Handbook. The purpose of the EU BIM handbook is:

"This alignment brings clarity and repeatability to this digital innovation across Europe – reducing divergence, misunderstanding and waste. It will accelerate growth and encourage competitiveness of the construction sector, especially its SMEs" (Source: Handbook for the introduction of Building Information Modelling by the European Public Sector, page 4)

The EU BIM handbook comes with a number of recommendations to public clients in relation to what should be implemented with digital collaboration on infrastructure and construction projects, and combined with the ISO/CEN 19650⁶, based on British PAS 1192-2:2013⁷, provides an indication of what will be the focus of an upcoming framework statement.

⁵ *Handbook for the introduction of Building Information Modelling by the European Public Sector, 2017*

⁶ *Organization of information about construction works - Information management using building information modelling, 2018*

⁷ *Specification for information management for the capital/delivery phase of construction projects using building information modelling, 2013*

The EU BIM Handbook provides a fine example of a new overall framework for digital collaboration, with elements also seen in the Danish ICT-regulations 118 and 119, like ICT-coordination, handling of digital building objects and digital communication.

Comparing the new framework with the Danish ICT-regulations from 2013 and MT Højgaard's analyses of the subsequent digital practice, gives an image of the extent to which a new framework will give the construction industry and clients a more effective digital collaboration, see Appendix B.

The new framework has a contract including the roles and responsibilities of the parties in relation to digital cooperation and the basis of the project, like in the Danish ICT-regulations where the client either must *ensure* or *require* the digital work as specified in the individual sections of the ICT-regulation. Operator and client needs regarding the delivers of information of the digital cooperation must be *translated* to requirements. The requirements must be specified and cover details of BIM-deliverables, management processes in connection with BIM, software platforms and definitions of level of development and information. There is in the Danish ICT-regulations no link between the client's needs and the requirements. According to the Danish ICT-regulations, the client must require IFC because it is stated in the ICT-regulation and not because there is a business need.

The BIM Execution Plan (BEP) for the project must be based on the needs and demands of the client and operator in relation to digital cooperation and a comparison of the parties' ability to participate in digital cooperation, which is a basis for the clients to ensure that the parties on the project live up to their roles and responsibilities. Requirements for assessment of the parties' ability to participate in the digital collaboration on the project, is based on the documentation. This creates a real basis for the parties to digital cooperation to exploit their potential and, together create an even better common practice.

Systematic exchange of the project's Building information modeling (BIM) in the open Industry Foundation Class (IFC) format (ISO 16739: 2013) is a key element in the new framework, and this is corresponding to requirements in the Danish ICT-regulations. 3D design must be "*object oriented*" which means that the design is not drawn in 2D but modeled in 3D with focus on both geometry (LOD) and properties (LOI), which is also required in the Danish ICT-regulations.

Central to the digital collaboration is the requirement that the individual is responsible for the quality of its digital delivery and use of a process of information management. The EU BIM handbook refers to the term *Container* from the ISO/CEN standard 19650 part 1, as a hub for 3D-models, drawings, documents, photos, etc. corresponding to project webs in the §5 Digital communication in the Danish ICT-regulations. Common Data Environment (CDE) should be the basic principle that contributes to quality assurance (QA) of the digital information and QA of that information and production basis are managed and shared efficiently and correctly. The parties on the project must have competencies and abilities to fulfill the roles of the project in accordance with ISO/CEN 19650-1 and -2 which is a completely new requirement compared to the current practice in Denmark and the Danish ICT-regulations.

All of the above recommendations are part of the future ISO/CEN standards 19650-1 and -2⁸ for the digital collaboration with BIM, which can also be seen as the foundation of the EU BIM framework for the digital collaboration.

The change of the digital collaboration on infrastructure and construction projects

The future framework will contain both elements that are known, as from the Danish ICT-regulations 118 and 119, and new elements. This gives the industry a possibility for continuing using well proved practices and supplement with new necessary elements and processes. The future framework in the EU BIM Handbook contains elements:

1. which are known and works
2. which are new and works
3. that ensure that the digital collaboration is possible.

1. The future Framework contain elements which are known and works

The Framework contains elements which are known and works. For example does the ICT-requirements regarding **roles and responsibilities** ensure that the client defines the cooperative parties and the process for the digital collaboration, and by that sets up the framework conditions on the project. This also regards the information exchanges which must be defined in the project's model progression specifications, see e.g. MPS in *Building Component Catalogue with LOD levels* – version 4.0, November 2017 and *Closing the gap with VDC and early involvement*, March 2016: The client should start by setting a clear goal for the digital collaboration on the project, which could also contribute to increased productivity similarly as described in the book *A practical guide to BIM in construction and infrastructure projects*, October 2016:

"For cooperation on the project's BIM to add most value to the project participants, it is necessary to define the objective for the use of BIM on the project. This will ensure a common effort and alignment of expectations about common objectives that support the client's goals as well as achievement of the objectives of the individual project participants".

The ICT-requirements also call for a clarification of who is responsible for the ICT-coordination and ICT-management on the project. It is important to place the responsibility for the different functions so that it is known for all parties who are responsible for what.

Another well-known element in the framework is the requirements for model exchange in the **open IFC format** which is described in the white paper *IFC – A driver for design quality in the AEC industry*, August 2014:

"The data set of the analysis consists of a record of quality assessments from 153 projects tendered in five different procurement forms and at a variety of design development stages. In spanning the 153 projects the data set consists of 381 different discipline-level contributions, each comprised of 3D models and/or drawings, project specifications and more. Projects using IFC within a mandatory framework showed an increase in design quality of 45% compared to projects without IFC".

⁸ *Organization of information about construction works - Information management using building information modelling, 2018*

The last years of exchanging models has shown a good practice for using the IFC format which contributes to improve the quality of the design on the projects. And still the practice with **object oriented design** increases, which heighten the possibilities for the use of elements and objects in the model to apply properties. This opens for more information in the BIM-models and enriches the model and the basis for decision making on the projects, e.g. *Classification in Addressing classification in the Danish AEC industry*, August 2015:

“Classification in the AEC (Architecture, Engineering and Construction) industry is generally characterized by little international standardization. Differences in cultures and legislations have created a variety of differing methods and practices which have affected how information in the AEC industry is arranged for individual countries. Classification is intended to facilitate the process of effectively sorting the vast amount of information associated with a construction project”.

The optimised digital platform of the projects consisting of BIM-models and objects exchanged by open formats and standards and clarification of the ICT-responsibilities on the project, makes it possible to **manage quality and information**, which has also shown to be still more often seen on the projects, e.g. *The Quality of Design Material in Denmark*, April 2014 and *Critical clashes in the 3D design*, February 2017.

All in all it proves that we have an existing framework that supports the project and ensures an increasing process for digital construction.

2. The future Framework contains elements which are new and works

As a new element for the Danish construction industry the future framework introduces the BEP which defines an overall plan for the use of BIM and digital construction and collaboration on the project, e.g. as described in the white paper *Closing the gap with VDC and early involvement*, March 2016. The white paper shows that BEPs often do not provide the data required by the contractors on projects, where the contractors are not involved from the outset. In order to address this problem the client can require that:

- The overall framework for digital collaboration requires that all parties must ensure that their digital production can be used by and together with other stakeholders in the project
- The collaboration shall at a minimum take place around an open industry standard as IFC. The goal is that the digital collaboration shall provide the client with a good basis for decision-making in terms of execution time, total cost of ownership and subsequent operation and maintenance
- The contractor must be involved as early as possible in order to realize the project. The first focus must be on the choice of solutions and 4D production planning that enhances project efficiency and reduces execution time.

The client that translates these recommendations to the requirements contained by the project's BEP, will ensure a framework for collaboration where the projects profitability is increasing and the stakeholder's exposure to risks and conflicts is reduced.

Another new element is **managing the digital basis**, here the new standards set up a framework for how to collaborate on the digital project and how to exchange information during the design and construction process. CDE is already described in a Danish context through *VDC manual for civil works with Autodesk tools*, July 2018.

3. The future Framework contains elements that ensure that the digital collaboration is possible

The future framework also set up a set of requirements in relation to digital cooperation, which regards the competencies and abilities among the different parties on the project to fulfil the roles of the digital cooperation. This emphasises the necessity of comparing the digital ambitions in the project defined in the BEP with the actual and present competencies. Often there will be a need for heighten the competencies at the different collaborative parties to ensure, that the clients ambitions for the project is fulfilled, as described in the book - *A practical guide to BIM in construction and infrastructure projects*, October 2016, and the white paper *Closing the gap with VDC and early involvement*, March 2016. The competencies and resources must be able to handle more than one important element in the digital project and the standard processes, also imply requirements for resources and competencies, e.g.:

- BEP as a framework for the cooperation
- Design quality
- BIM-coordination and ICT-management.

It is important to establish common agreements on roles and responsibilities because it creates the right framework for using competencies and abilities in relation to digital collaboration. It also creates optimisation of the cooperation on the project, e.g. as when the design is converted to concrete procurement, building components and work processes. Therefore all participants are required to:

- Deliver the right information at the right time to the right person
- Jointly plan the individual's contribution, using methods from Lean construction and Location-based construction management
- Know the mutual expectations through clear requirements.

Final summary and recommendation

A new framework as described in the EU BIM handbook will give the construction industry and clients a framework for better digital collaboration on the projects than today, and in the long term also contribute to an even better digital practice in our industry.

Today we collaborate digitally on most projects inspired or defined by the framework of the Danish ICT-regulations 118 and 119, in some projects the requirements are even increased and thereby we mature our digital skills and collaborative practice.

Clear requirements provides an effective BIM-collaboration, see *Value drivers in the Danish national ICT regulations*, December 2014. By international standardization we can create a even better foundation for the sharing of experiences concerning the BIM implementation and application, which for example can be seen in relation to an open industry standard as IFC. We can increase the values of our respective initiatives, when results and experiences are shared across our industry.

The interdisciplinary cooperation on the projects can according to the EU BIM Handbook be better by adopting a common approach to BIM through collaborative working and sharing of best practice and reuse of existing developments and knowledge like this white paper.

References:

- *A practical guide to BIM in construction and infrastructure projects*, October 2016
- *Building Component Catalogue with LOD levels – version 4.0*, November 2017

- *Handbook for the introduction of Building Information Modelling by the European Public Sector*, EU, 2017
- *VDC manual for civil works with Autodesk tools*, July 2018
- White paper entitled *Critical clashes in the 3D design*, February 2017
- White paper entitled *Efficient digital delivery of construction projects with COBie*, August 2016
- White paper entitled *The strength of the local BIM efforts in a larger perspective*, May 2016
- White paper entitled *Closing the gap with VDC and early involvement*, March 2016
- White paper entitled *Industrialised BIM - using data to drive productivity*, October 2015
- White paper entitled *Addressing classification in the Danish AEC industry*, August 2015
- White paper entitled *Value drivers in the Danish national ICT regulations*, December 2014
- White paper entitled *IFC – A driver for design quality in the AEC industry*, August 2014
- White paper entitled *The Quality of Design Material in Denmark*, April 2014.

Appendix A, ICT Regulation 118

Regulation concerning the use of information and communication technology (ICT) in public construction.

Pursuant to Section 2(1), Section 5(1), Section 8 and Section 8a of the Danish Act on Public Construction Activities, cf. Consolidated Act no. 1712 of 16 December 2010, as amended by Act no. 623 of 14 July 2011, the following is laid down:

Area of application

1.-(1) The Regulation applies to the construction of buildings, the conversion and extension of buildings, the renovation and maintenance of buildings, and facilities related to such buildings with regard to:

- 1) Construction with the Danish State as the Client for an estimated contract sum of DKK 5 million excluding VAT, or higher.
- 2) Construction for an estimated contract sum of DKK 5 million excluding VAT, or higher, of which at least 50 per cent is financed in full or in part by State loans or subsidies.
- 3) Construction for an estimated contract sum of DKK 5 million excluding VAT, or higher, for the use of institutions of which the operation is paid by the State, when the subsidy constitutes at least 50 per cent of the operational expenses.
- 4) Construction with a region or municipality as the Client for an estimated contract sum of DKK 20 million excluding VAT, or higher.
- 5) Construction for an estimated contract sum of DKK 20 million excluding VAT, or higher, which is financed in full or in part by loans or subsidies of at least 50 per cent from regions and municipalities.
- 6) Construction for an estimated contract sum of DKK 20 million excluding VAT, or higher, for the use of institutions of which the operation is paid by regions and municipalities, when the subsidy constitutes at least 50 per cent of the operational expenses.

(2) The Regulation does not apply to construction for which public support is granted pursuant to the Danish Act on Public Housing, etc., the Danish Act on Private Care Dwellings and the Danish Act on Urban Renewal and Urban Development.

2.-(1) In conjunction with construction projects concerning renovation and maintenance, the Client may waive fulfilment of one or more of the Regulation's requirements if the costs of the fulfilment of the requirement(s) in question do not match the benefits.

(2) Nonetheless, the Client may not waive the regulations in Section 8 concerning digital invitations to tender and bids via a digital system.

ICT coordination

3. The Client must ensure that throughout the construction project there is coordination of the overall use of ICT between all of the parties involved.

Handling of digital construction objects

4.-(1) The Client must require that throughout the construction project digital construction objects are structured, classified, named, coded and identified on a uniform basis and to a specific degree of detail. In this respect the Client must require that the construction objects are provided with the information and characteristics that are of relevance to the subsequent management, operation and maintenance.

(2) The Client must ensure that guidelines are laid down for the handling of digital construction objects throughout the course of the construction project.

Digital communication and projectweb, etc.

5.-(1) The Client must require that a system be used for digital communication and archiving of all relevant information during the course of a construction project.

(2) The Client must ensure:

- 1) that a plan is drawn up concerning which parties are to make which information available in the system, and at which times;
- 2) that information can be obtained from the system and transferred to other systems, and that the plan that is drawn up includes specification of which transfers are required during the course of the project and on the completion of the construction work, cf. Section 10;
- 3) that the system includes access control, notifications and logs;
- 4) that it is determined which file formats are to be used; and
- 5) that it is determined which meta data is to be connected to the individual file types.

Use of digital construction models

6.-(1) As part of the competitive element of competition-based bidding rounds, the Client must require that the proposals received include digital, object-based construction models, as well as visualisations made on the basis of these models. Construction models and visualisations must document the proposals' architectural, functional and technical conditions at a specified information level.

(2) The Client must ensure:

- 1) that the competition programme outlines requirements of the models' structure and information content, cf. Section 4, based on the size, nature and complexity of the competition;
- 2) that the number and location of visualisations are determined on the basis of the size, nature and complexity of the competition; and
- 3) that object-based construction models are provided in IFC format.

7.-(1) During project design and execution the Client must require that object-based construction modelling be used.

(2) The Client must ensure:

- 1) that agreement is reached concerning which discipline and shared models are to be prepared;
- 2) that each of the parties with responsibility for models prepares the necessary discipline models, of which the content and use are specified in relation to the service provided by the individual party;
- 3) that discipline models are coordinated via one or several shared models for the purpose of simulation, clash detection, bill of quantities, drawings and specifications; and
- 4) that the models are made available in IFC format.

Digital invitations to tender and bids

8. The Client must require that for invitations to tender for construction works digital invitations to tender and bids are applied, by using a digital system. The tender documents must be drawn up so that, to a relevant extent, the documents can be used digitally by the bidders in conjunction with their submission of bids, and so that bids are structured in accordance with the structure otherwise used in the construction project, cf. Section 4.

9. To the extent that the tender includes bill of quantities, the Client must ensure:

- 1) that bill of quantities are included in the tender documents;
- 2) that the tender documents for each contract include bills of quantities as well as relevant digital, object-based construction models from which quantities can be extracted;
- 3) that models are made available to the bidder in IFC format; and
- 4) that the tender documents show the basis on which the quantities are calculated, including the measurement rules and/or measurement methods that are used.

Digital delivery on handing over the construction project

10.-(1) In consultation with the Contractor, the Client must set requirements concerning the digital submission of the information that is deemed to be relevant for:

- 1) documentation of the construction work;
- 2) documentation of the construction project;
- 3) operation and maintenance; and
- 4) the future management of the property.

(2) The Client must ensure:

- 1) that digital delivery on the handover of the construction project is included in the agreements with advisers, contractors and suppliers;

2) that the agreements include the handover's extent, structure, classification, identification and formats; and

3) that object-based construction models are provided in IFC format.

Digital information concerning defects

11. The Client must ensure that digital lists of defects are used, which describe the registered defects in accordance with the structure determined for the project, cf. Section 4.

Entry into force and transitional provisions

12.-(1) The Regulation enters into force on 1 April 2013 and applies to construction projects that are initiated as from and including this date.

(2) Regulation no. 1381 of 13 December 2010 concerning requirements of the use of information and communication technology in construction projects is repealed as of 1 April 2013. However, the Regulation will continue to apply to construction projects that are initiated before 1 April 2013.

Appendix B, The “future framework”

The “future framework” from EU BIM	EU BIM Handbook	Danish ICT regulations 118 and 119	References to publications from MT Højgaard
Roles and responsibilities	3.2.1 Policy, page 60	The client either must ensure or require the digital work as specified in the individual sections of the ICT regulations 118 and 119 §3, §7.2.2 and §7.2.3	MPS in <i>Building Component Catalogue with LOD levels</i> – version 4.0, November 2017 and white paper <i>Closing the gap with VDC and early involvement</i> , March 2016
Requirements in relation to digital cooperation	3.2.1 Policy, page 62	Partly	White paper <i>Efficient digital delivery of construction projects with COBie</i> , August 2016
Competencies and abilities to fulfil the roles of the digital cooperation	3.2.1 Policy, page 66 and 3.2.3 Process, page 78	New	Necessary resources and competencies in the book - <i>A practical guide to BIM in construction and infrastructure projects</i> , October 2016 and white paper <i>Closing the gap with VDC and early involvement</i> , March 2016
The BIM Execution plan	3.2.1 Policy, page 68	New	White paper <i>Critical clashes in the 3D design</i> , February 2017 and White paper <i>Closing the gap with VDC and early involvement</i> , March 2016
Open IFC format	3.2.2 Technical, page 70	Corresponding to requirements in ICT regulations 118 and 119 §6.2.3, §7.2.4, §9.3 and §10.2.3	White paper <i>IFC – A driver for design quality in the AEC industry</i> , August 2014 and white paper <i>Value drivers in the Danish national ICT regulations</i> , December 2014
Object oriented design	3.2.2 Technical, page 72	Client must require digital object-based construction models as ICT-regulations 118 and 119 in § 4 <i>Handling of digital construction objects</i>	White paper <i>Addressing classification in the Danish AEC industry</i> , August 2015
Quality and information management	3.2.3 Process, page 74	Partly, but no focus on the quality of the design and information, only ICT-coordination in ICT regulations 118 and 119 §3	White paper <i>The Quality of Design Material in Denmark</i> , April 2014 and white paper <i>Critical clashes in the 3D design</i> , February 2017
Managing the digital basis	3.2.3 Process, page 76	Partly, ICT regulations 118 and 119 §7.2.2, §7.2.3 and § 7.2.4	<i>VDC manual for civil works with Autodesk tools</i> , July 2018 and white paper <i>Critical clashes in the 3D design</i> , February 2017